Great Falls, Montana
—10th AVENUE SOUTH—

IMPROVEMENT PLAN

·FINAL REPORT·

Robert Peccia & Associates
Planners - Engineers - Designers

GREAT FALLS, MONTANA

TENTH AVENUE SOUTH IMPROVEMENT PLAN

FOR THE

MONTANA DEPARTMENT OF HIGHWAYS

PLANNING AND RESEARCH BUREAU

In cooperation with the
Department of Transportation
Federal Highway Administration

By:
ROBERT PECCIA & ASSOCIATES
HELENA, MONTANA
March, 1979

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April 10, 1979

James W. Hahn, Chief
Planning and Research Bureau
Montana Department of Highways
Helena, Montana 59601

Dear Mr. Hahn:

Submitted with this letter are 150 copies of the final report for the Tenth Avenue South Improvement Plan and 20 copies of the Technical Supplement as required by our contract agreement.

We have tried, in all instances, to base our conclusions on fact and reason, and we believe our recommendations are sound. The result is, in our opinion, a practical and implementable program of improvements for Tenth Avenue South.

We have sincerely enjoyed our participation in this project, and want to thank the Department of Highways and Great Falls for offering this opportunity to us. We also appreciate the guidance and support provided by the Great Falls Technical Advisory Committee, in particular John Mooney City-County Planning Director and his staff.

Yours very truly,

ROBERT PECCIA & ASSOCIATES

Robert J. Peccia

Robert J. Peccia

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CHAPTER I
INTRODUCTION AND PROJECT SCOPE

A. AUTHORIZATION

In April of 1977, the Montana Department of Highways in cooperation with the Great Falls City-County Planning Board, the City of Great Falls, Cascade County, and the Federal Highway Administration prepared a prospectus for a consultant contract for a study of Tenth Avenue South in Great Falls. The prospectus included a discussion on the characteristics and problems of Tenth Avenue South, possible improvements that might be made, and goals and objectives for the proposed study.

The prospectus was sent to several consultants with a letter requesting proposals to conduct the work. Interested consultants submitted technical proposals and made a presentation on their qualifications, experience, and proposed method of approach to the study in June, 1977 in Great Falls to a consultant review committee. The consultant review committee recommended that the consultant firm of Daily-Peccia and Associates be selected by the Montana Department of Highways to conduct the study for Tenth Avenue South. A contract was awarded to this firm by the Department of Highways in November of 1977. Funds to conduct the project were obtained from the Federal Aid Primary Urban Extension System Funds allocated to the Great Falls Urban Area.

B. PURPOSE OF PROJECT

Tenth Avenue South is the heaviest traveled street in Montana according to Department of Highways permanent counter records. It functions as both a through arterial and as a commercial street providing access to adjacent businesses. A number of problems have surfaced recently with the functioning of Tenth Avenue South including high accident rates, poor spacing of traffic lights, deteriorating pavement, encroachment of commercial activity on the street functions, and little attention paid to beautification.

A number of improvements on Tenth Avenue South have been proposed in the past including removing the street lights from the median, improving the drainage, and limiting the direct access to Tenth Avenue South by restricting curb cuts. The two primary purposes for conducting this project are as follows:

(1) To improve the traffic flow and safety characteristics and to increase the capacity of Tenth Avenue South.

(2) To provide a coordinated plan of improvements so that the improvements that are proposed will be done in a logical and efficient manner.

The goals and objectives of the project as listed and described in Section D provide a detailed listing of the purposes of the project.

C. DESCRIPTION OF PROJECT

This project included collecting information on the traffic and physical characteristics of the street and conducting a number of technical analyses to determine what the problems are, and

identifying potential solutions to these problems. The improvement plan selected was based on the problems identified and an analysis of the benefit-cost of each proposed improvement. A sequence of improvements was established such that each improvement would be oriented toward an ultimate design plan for the street.

Study limits for the project were from the east end of the Warden Bridge, over the Missouri River, to the 57th Street intersection. It is noted that an additional two lanes for the Warden Bridge are programmed for construction in 1981. The study assumes that this improvement will be accomplished on schedule.

It should also be pointed out that Tenth Avenue South is the connecting link between FAP 60 entering Great Falls from the west and Interstate 15, as well as being a street where major business activity occurs. This dual function of the street causes conflicts between through traffic and traffic desiring business access. This problem has been specifically noted and addressed in the study.

A future project that will have a major impact on Tenth Avenue South is the proposed south arterial route that will provide a southerly route connecting at 57th Street and at the airport interchange on I-15. A location study for this project is underway and should be completed sometime in early 1980.

Traffic analyses conducted for the Tenth Avenue South project included: traffic volume counts and adjustments, intersection turning movement counts, travel time and delay studies, intersection delay studies, accident studies, pedestrian and bikeway studies, and an off-street parking and traffic circulation study.

In addition to the traffic studies, investigations were made into the following areas of concern: lighting system, drainage system, pavement adequacy, traffic signal systems, geometric design, striping and signing, beautification, capacity capabilities, and traffic access to Tenth Avenue South.

Each of these studies are described in detail in this report. At the conclusion of the analysis of each investigation that was undertaken, the problems were identified and proposed improvements suggested. A final improvement plan was prepared by analyzing the benefit-cost ratio of each improvement proposed and by sequencing the improvements in a logical fashion so that the most desirable improvements could be installed first. The sequencing of improvements was done in a *stage construction* fashion so improvements done now would not have to be removed later.

D. GOALS AND OBJECTIVES

To guide the consultant in carrying out the project, goals and objectives were established by the Department of Highways and the Great Falls Technical Advisory Committee. These goals and objectives are as follows:

Goal No. 1

Obtain maximum efficiency and safety in terms of minimum delay, maximum capacity, and minimum traffic conflicts on Tenth Avenue South relative to the movements of people and goods over the surface street system.

Objectives

(1) To identify operational problems and conflict areas.

(2) To recommend a signal control system that is compatible with the traffic characteristics and roadway configuration.

(3) To identify the bottlenecks and recommend specific improvements to increase traffic flow and improve safety at these locations.

(4) To recommend improvements to increase capacity and safety on Tenth Avenue South within existing right-of-way limits.

(5) To make specific recommendations concerning improvements to the drainage system and driving surface.

(6) To recommend improvements, modifications, or relocation of existing lighting, to include proposed pole locations, candlepower, and estimated costs.

(7) To determine (a) whether the commercial park concept would improve traffic flow on Tenth Avenue South and (b) whether owners of property along Tenth Avenue South would be receptive to such a plan.

Goal No. 2

To decrease traffic congestion on Tenth Avenue South by constructing a south arterial route, south of Great Falls, possibly along the preliminary alignment established by the Department of Highways.

Objectives

(1) To determine the number of lanes that will be required to accommodate traffic on Tenth Avenue South and the proposed south arterial based on projected traffic volumes already compiled by the Department of Highways, Planning and Research Bureau.

(2) To determine the overall effect of traffic movements on Tenth Avenue South if a south arterial were to be constructed.

The City-County Planning Board has adopted transportation goals, objectives and subobjectives as part of the Great Falls transportation planning process which have been addressed by the consultant in this study. A list of these goals and objectives is included in the Tenth Avenue South Improvement Plan - Technical Supplement.

E. ORGANIZATION

This project is on an urban extension of a Federal Aid Primary Route and consequently is under the direct jurisdiction of the Montana Department of Highways. The Department of Highways contracted the study to the consulting firm of Daily-Peccia and Associates. Federal funds administered by the U.S. Department of Transportation - Federal Highway Administration are involved in the study, and the Federal Highway Administration also monitors the study.

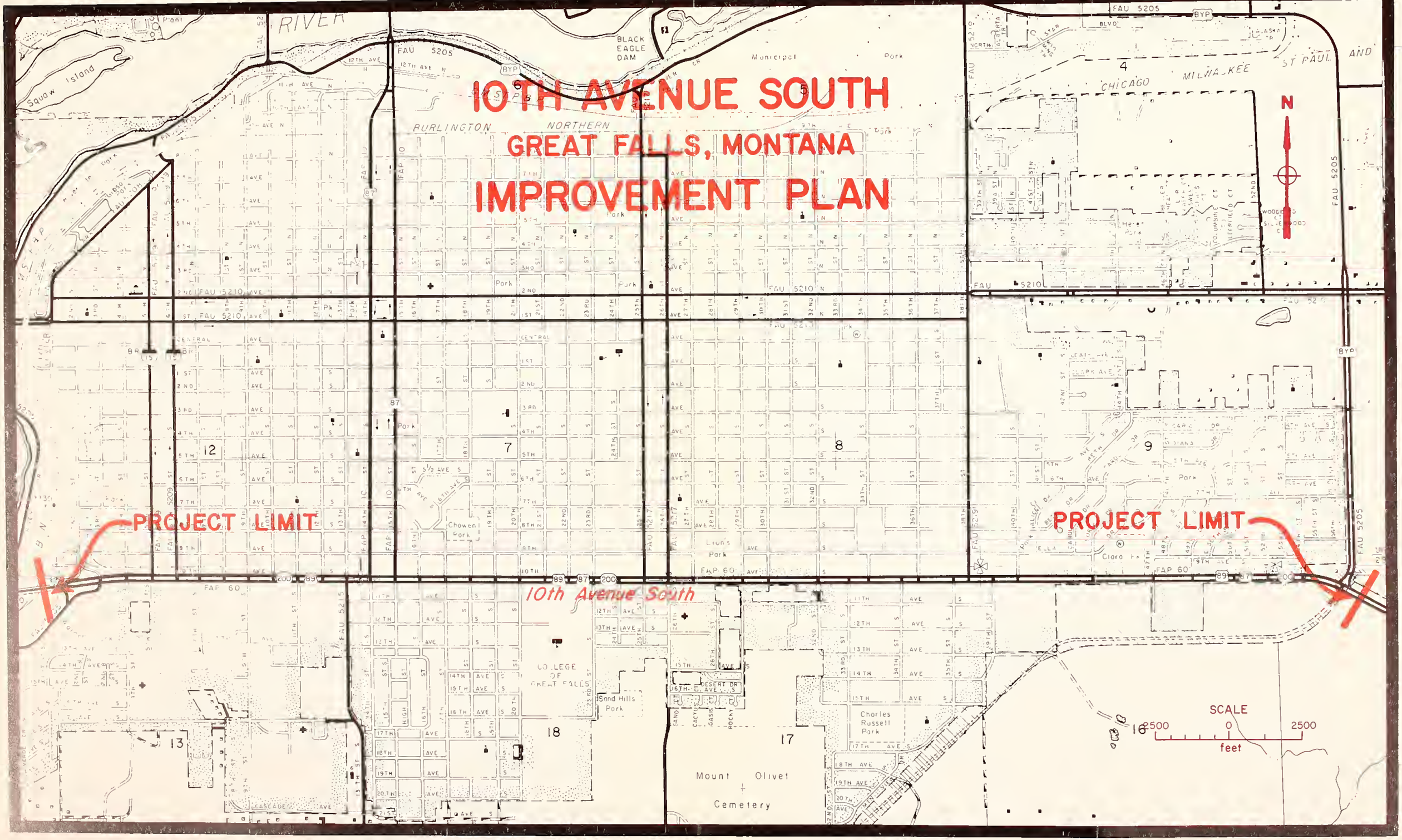
The consultant presents progress reports and findings to the Great Falls Technical Advisory Committee which is comprised of members from the City of Great Falls, Cascade County, City-County Planning Board, Montana Department of Highways, Federal Highway Administration, Malmstrom Air Force Base, Railroads, and citizen members.

In addition to the formal organization responsibilities, reviews and responses have been solicited from the Great Falls City Commission, Great Falls Community Beautification Association, and the Great Falls Chamber of Commerce at meetings held with these groups.

10TH AVENUE SOUTH

GREAT FALLS, MONTANA

IMPROVEMENT PLAN



CHAPTER II

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

A. SUMMARY

B. CONCLUSIONS

C. RECOMMENDATIONS

CHAPTER II
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

A. SUMMARY

The analysis conducted for this project and presented in this report demonstrates that there are a number of major problems with both the operational characteristics and physical features of Tenth Avenue South. A series of improvements designed to provide for better traffic flow and to correct the physical problems has been developed and is contained in Chapter XIV - *Recommended Improvement Plan*.

The recommended improvement plan lists improvements to the street lighting system, traffic and street signs, traffic control equipment and systems, removal of some driveway accesses, modifications to the existing traffic patterns, improving the pedestrian and bikeway facilities, improving the storm drainage facilities, reconstructing the pavement section, and widening portions of the street from a four-lane to a six-lane facility. Recognizing that all of these improvements cannot be funded simultaneously, the improvement plan has been sequenced to provide for immediate improvements that could be done to improve the traffic flow and reduce accidents. The total improvement program could be accomplished in stages as funds become available, which is considered to be a realistic and practical approach for the implementation of the proposed improvements.

B. CONCLUSIONS

Most of the improvements contained in the improvement plan are needed immediately. If a program for implementing these improvements is not implemented in the near future, increasing traffic congestion, deteriorated and cracked pavement, and increasing accident rates can be expected. Although a major investment will be required to provide the proposed improvements, the heavy traffic volume and importance of this major arterial street to Great Falls both at the present time and in the future would seem to justify the need for the required investment.

C. RECOMMENDATIONS

Every effort has been made to assure that the recommended improvements contained in this report are needed for the efficient operation of Tenth Avenue South, and that the recommendations are based on sound and factual information. It is recognized that the improvements proposed will have to compete against other transportation projects in Great Falls because of limited funding. However, it is believed that the proposed improvements are urgently needed to maintain efficient travel on Tenth Avenue South, and that the improvements will rate a high priority.

The improvement plan has been developed so that each improvement can be examined somewhat independently, and provide immediate benefits as each improvement is implemented. It is recommended that the improvements be assigned priorities according to the relative merits of each, and that these improvements be incorporated into the Great Falls Transportation Improvement Program.

CHAPTER III

TRAFFIC STUDIES

A. TRAFFIC COUNTS

B. INTERSECTION TURNING MOVEMENT COUNTS

C. TRAVEL TIME AND DELAY STUDY

D. INTERSECTION DELAY STUDY

E. ACCIDENT STUDIES

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CHAPTER III
TRAFFIC STUDIES

A. TRAFFIC COUNTS

(1) Permanent Traffic Counter

A permanent automatic traffic counter and recorder owned and operated by the Department of Highways is located on Tenth Avenue South between 9th Street and 10th Street. Traffic records for this permanent counter are available from 1965 to the present. The traffic counter operates by means of a magnetic loop detector concealed in the pavement and connected to an automatic counter and recorder, and traffic volumes are recorded for each hour of the day.

The traffic recorder is located at a high traffic volume location on Tenth Avenue South and provides excellent information on traffic variations, historical traffic growth, and traffic characteristics. Figure No. 1 shows the historical traffic growth from 1965 to the present. From the graph it is noted that traffic volumes showed moderate change except for a sharp increase in traffic for the years 1976 and 1977. Traffic for 1978 has leveled off and is very close to the 1977 traffic volumes.

Monthly variations in average daily traffic can also be established and examined from the information provided by the permanent traffic recorder. Figure No. 2 shows monthly variations in average daily traffic for the years 1975, 1976, 1977, and 1978. In May of 1977, the traffic recorder malfunctioned, and the count for that month was adjusted. It can be noted from this graph that the highest traffic volumes occur during the months of June, July, and August. The lowest traffic volumes occur in the month of January. The 1978 traffic volumes are less than the 1977 traffic volumes from January through July, but then closely match or slightly exceed the 1977 volumes from August through October.

Hourly volume variations are shown in Figure No. 3 for October 10, 1977. This date was chosen because it closely resembles the annual average daily traffic for the year. This graph shows an unusual variation of traffic throughout the day in that traffic volumes increase to a peak at about noon with this peak being maintained until 6:00 p.m. with no well-defined short peak periods. This long and flat peak period occurring as it does is probably due to the dual function of the street in acting as an access for businesses as well as a through arterial, and that the street approaches capacity for the duration of the peak period with no ability to assimilate additional traffic.

(2) Observations of Traffic on Tenth Avenue South

According to the Department of Highways, Tenth Avenue South is the heaviest traveled arterial in Montana. Also affecting the traffic flow are the numerous driveway accesses, and poor spacing and location of some traffic signals. The heavy traffic volume combined with the dual function of providing land access and through traffic presents a unique challenge in determining applicable improvements that would meet these complex needs.

10TH AVENUE SOUTH
ANNUAL AVERAGE DAILY TRAFFIC VOLUMES

FIGURE 1

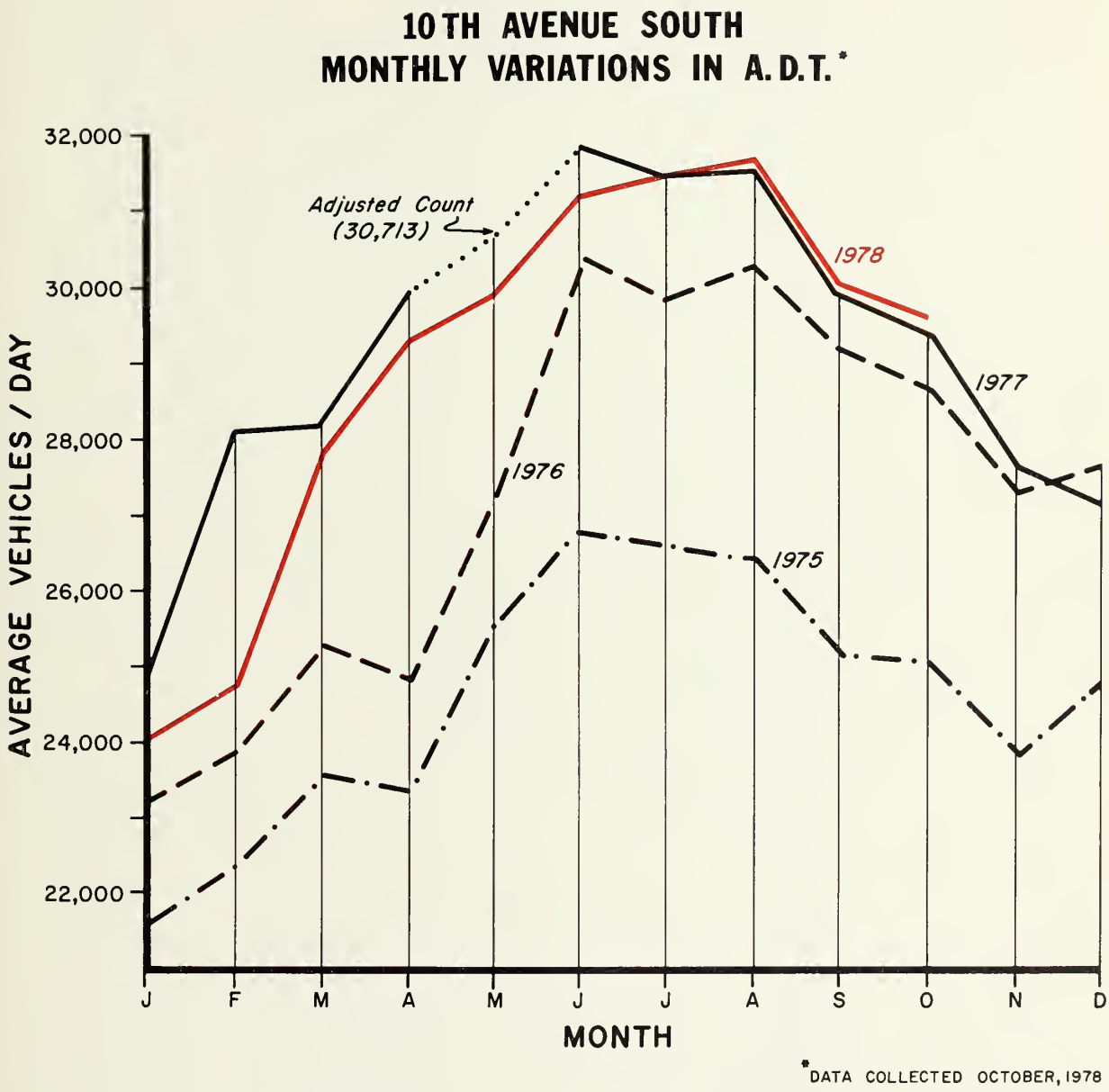

10TH AVENUE SOUTH
MONTHLY VARIATIONS IN A.D.T.*
32,000
30,000
28,000
26,000
24,000
22,000
AVERAGE VEHICLES / DAY
Adjusted Count
(30,713)
1978
1977
1976
1975
J
F
M
A
M
J
J
A
S
O
N
D
MONTH
*DATA COLLECTED OCTOBER, 1978

FIGURE 2

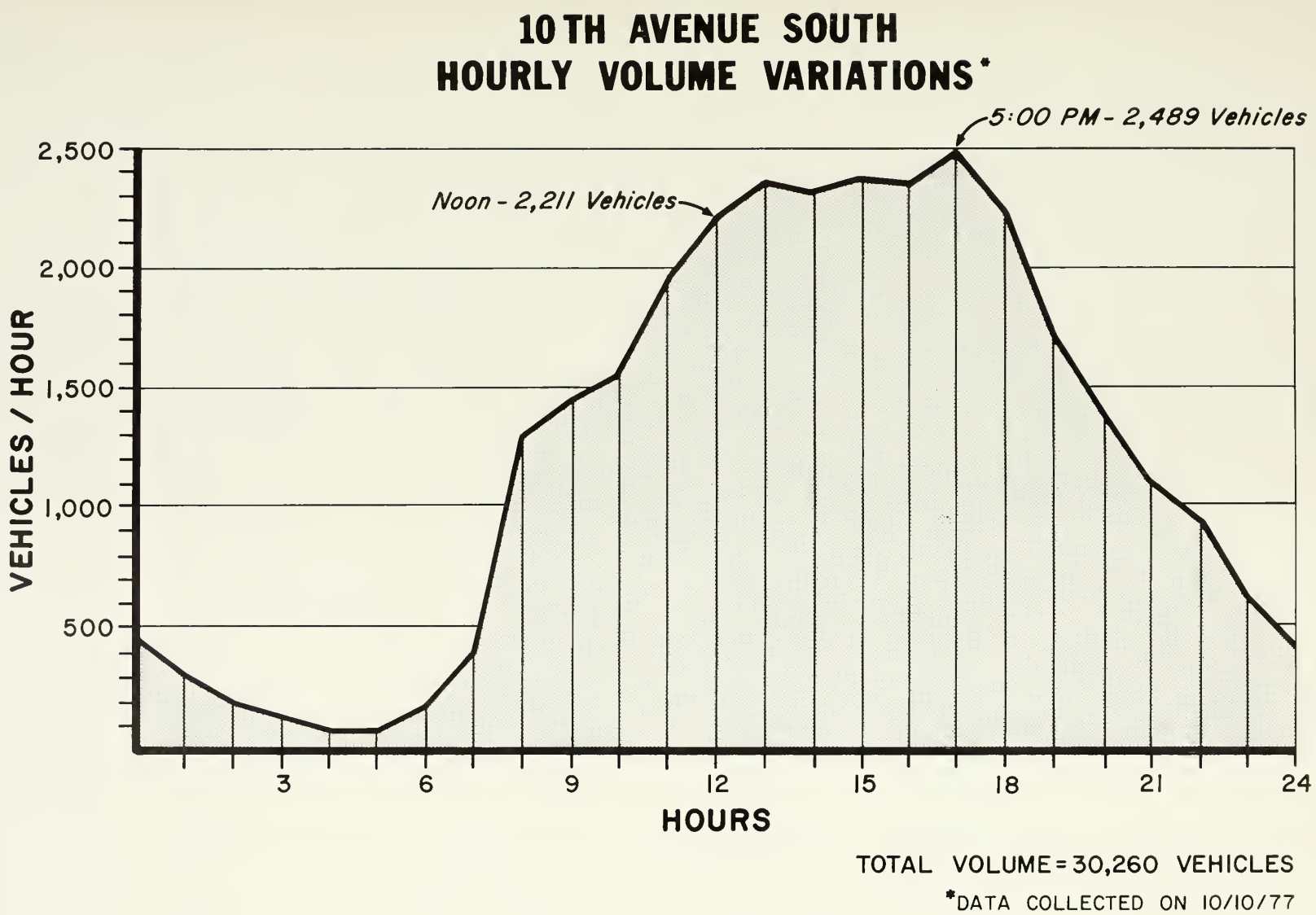

10TH AVENUE SOUTH
HOURLY VOLUME VARIATIONS*
5:00 PM - 2,489 Vehicles
Noon - 2,211 Vehicles
2,500
2,000
1,500
1,000
500
VEHICLES / HOUR
3
6
9
12
15
18
21
24
HOURS
TOTAL VOLUME = 30,260 VEHICLES
*DATA COLLECTED ON 10/10/77

FIGURE 3

B. INTERSECTION TURNING MOVEMENT COUNTS

(1) Intersection Counting Procedures

Manual intersection turning movement counts were made at 18 major intersections along Tenth Avenue South. All signalized intersections and intersections that have a potential of becoming signalized in the future were counted. Intersection turning movement counts are used to evaluate the need for and type of traffic control devices, settings for traffic signals, establishing geometric improvements to aid in handling traffic movements, and in intersection capacity calculations.

The manual counts were taken by two persons using traffic counter boards. Traffic volume counts were recorded in fifteen-minute increments for a minimum of two-hour periods during the morning, noon, and afternoon peak traffic volumes. It was determined, by examining the records of the permanent traffic counter that is located on Tenth Avenue South, that Monday through Thursday traffic volumes were relatively consistent. All counts were therefore made on these four weekdays. Each intersection count was made on one day to provide consistency to the traffic movement counts.

Thirteen of the eighteen intersection count locations were made by the consultant in the summer of 1978. Five count locations were available from turning movement counts done by the Department of Highways in 1976. All intersection turning movement counts were adjusted to average 1978 counts by using annual and monthly adjustment factors.

(2) Results of Turning Movement Counts

The turning movement counts show that the peak traffic volumes generally occurred during the afternoon peak from 4:30 p.m. to 5:30 p.m. The noon peak traffic volumes are very near to the afternoon peak, while the morning peak is much lower than either the noon or afternoon peak. Detailed information on the turning movement counts including work sheets and calculations is contained in a computation report on file at the Department of Highways, Planning and Research Bureau in Helena. Peak hour turning movements are contained in the *Tenth Avenue South Improvement Plan - Supplemental Report*.

(3) Conclusions of Turning Movement Counts

As the intersection counts were being done, it was observed that there was a substantial backup of traffic westbound from the Warden Bridge to as far east as 9th Street. This reflects the influence of the constriction of the two-lane Warden Bridge on the four lanes of traffic on Tenth Avenue South.

It was also noted that there are a significant number of drivers making turning movements going the wrong way on one-way streets, and then having to make erratic movements to correct their action. This may reflect the fact that the signing of the one-way streets is not adequate, and that the one-way couplets terminating on Tenth Avenue South may contribute to traffic confusion. Terminating one-way couplets on a major arterial is generally considered to be a poor practice.

(4) Traffic Volume Variations Along Tenth Avenue South

The volume counts from the intersection turning movement study were also used to show traffic volume variations along Tenth Avenue South. Figure No. 4, *Traffic Volume Variations Along Tenth Avenue South*, shows the two-way peak hour traffic volume for the legs of each intersection on Tenth Avenue South. Some variations in the traffic volumes may be inherent in the graph because of daily variations in traffic counts that were taken on different days.

Some interesting features of the traffic volumes that are reflected in the graph are: (1) the highest volume of traffic occurs at 20th Street, (2) the Warden Bridge bottleneck results in a rapid dropoff of traffic at 2nd Street, and (3) there is a marked difference in traffic volumes from the west half of Tenth Avenue South (Warden Bridge to 28th Street) to the east half (28th Street to 57th Street).

C. TRAVEL TIME AND DELAY STUDY

(1) Procedures Used

A travel time and delay study was conducted along Tenth Avenue South to evaluate the quality of traffic movement and to determine the locations, types, and extent of traffic delays. The information collected from this study included mean travel speeds and time-delay information when traffic flow is stopped or greatly impeded. The mean travel speed and time-delay results enable the traffic engineer to define problem locations where design and operational improvements may increase mobility and improve safety.

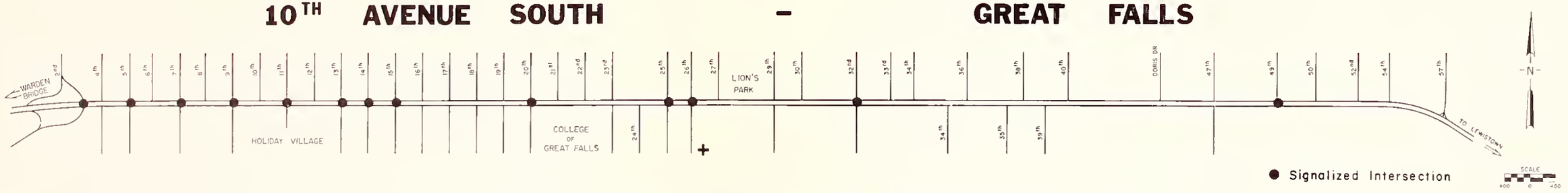
The method employed for this test was the test car technique whereby a test vehicle is driven along the study route matching the average speed of the traffic stream to the best of the driver's judgement. The time is recorded with a stopwatch at specific checkpoints along the route, and delays are recorded when the test car is stopped or forced to travel slowly. The time and distance information collected is used to compute travel times and delays.

(2) Tenth Avenue South Time and Delay Study

The time and delay study for Tenth Avenue South was done on Wednesday, July 26, 1978. The conditions for that day were clear and warm, and the traffic on that day was considered to represent an average mid-week summer day. One factor influencing the test is that the traffic signal at 20th Street was being maintenanced and operated with a flashing yellow light for most of the day. The delays at 20th Street are therefore not accurate and should not be used.

Forty-two runs were made (twenty-one in each direction) in both peak and off-peak hours starting at 7:00 a.m. and continuing until 6:00 p.m. Twenty-eight check points at various intersections were established at which elapsed time was recorded with a stopwatch. Delays that caused the test car to stop or travel slowly were also recorded. This information combined with the distance between check points was used to compute travel speeds, running speeds, and delays. Travel speed is the distance divided by the overall elapsed time, where the running speed is the dis-

10TH AVENUE SOUTH - GREAT FALLS



TRAFFIC VOLUME VARIATIONS ALONG 10th AVE. SO.

NOTES: DATA COLLECTED IN 4/76, 8/76, 9/76, 3/78, 4/78, 7/78, 8/78 ADJUSTED TO 1978 AVERAGE DAY PEAK HOUR

DATA REPRESENTS THE COMBINED TOTAL OF EAST BOUND VOLUME AND WEST BOUND VOLUME

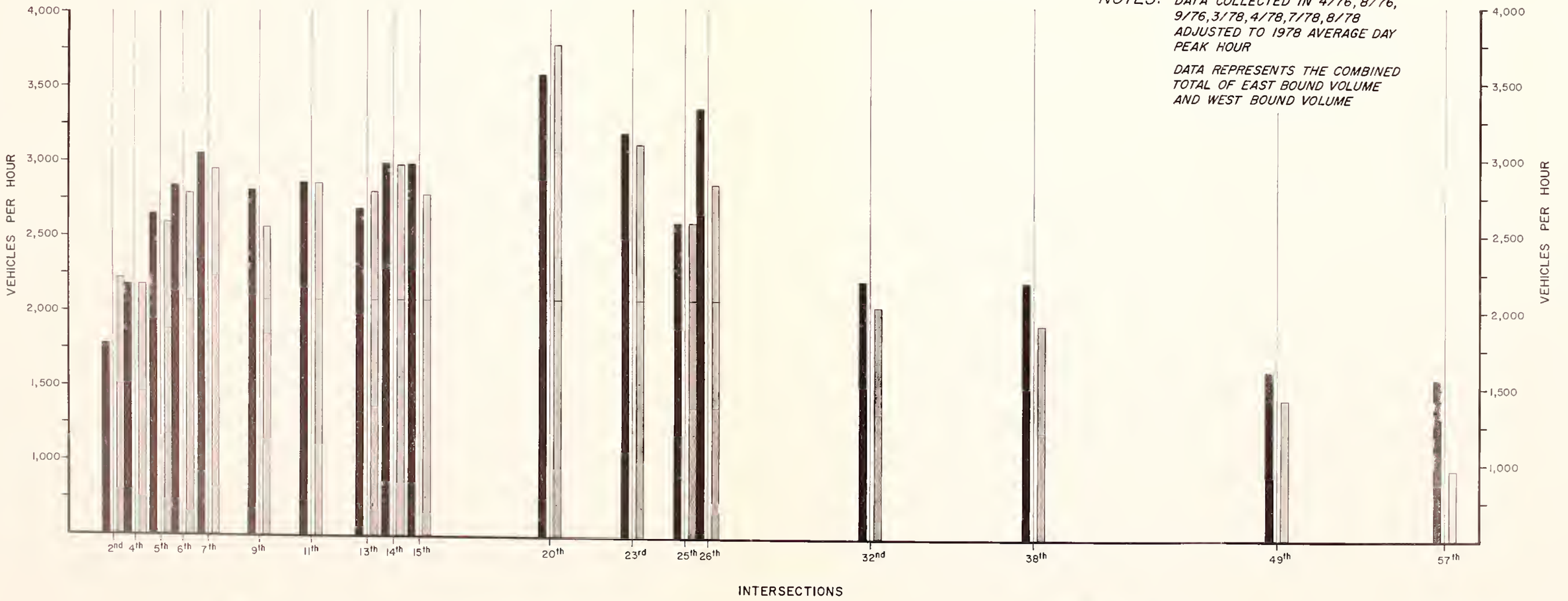


FIGURE 4

tance divided by the elapsed time minus delay time. The information collected is tabulated below for the length of the study section from Warden Bridge to 57th Street, a distance of 22,648 feet.

Direction of Travel	Average Running Speed (MPH)	Average Travel Speed (MPH)	Average Stopped Time (Sec.)
Eastbound			
Peak	29.7	26.0	75
Off-Peak	32.6	30.0	29
Westbound			
Peak	29.3	25.8	69
Off-Peak	31.9	29.3	44

Detailed information on the running speed, travel speed, and stopped time is available in a computation report maintained on file at the Montana Department of Highways, Planning and Research Bureau in Helena, Montana.

Graphic presentations of east and westbound travel speeds and average east and westbound delays are shown in Figures No. 5 and 6.

(3) Summary of Results

Reviewing the results of the travel time and delay study reveal that traffic on Tenth Avenue South moves surprisingly well. Travel speeds are relatively fast and in some cases exceed the speed limit. Most delays occur at the intersections of 2nd Street, 14 th and 15th Streets (one-way couplet) and 25th and 26th Streets (one-way couplet) but are not excessive. Delays occur at these intersections because of the higher side street traffic entering Tenth Avenue South in these locations.

D. INTERSECTION DELAY STUDY

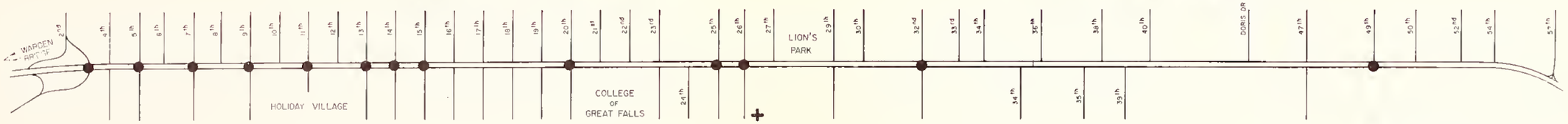
(1) Purpose of Study

Intersection delay studies are conducted to evaluate the effectiveness of an intersection in allowing traffic to enter and pass through or to enter and turn onto another route. As an integral part of this evaluation, the effectiveness of the traffic control equipment at the intersection plays an important role in how the intersection operates.

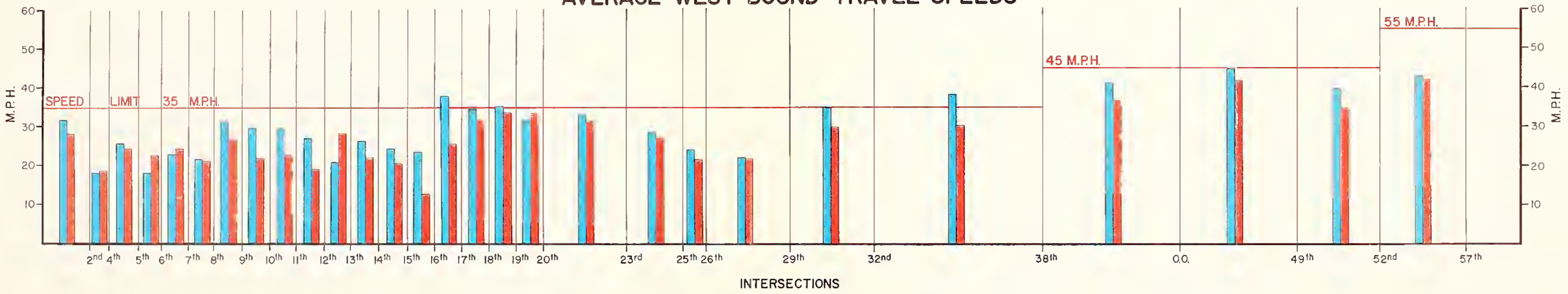
The information collected by this study is the stopped-time delay of vehicles at the intersection. Stopped-time delay is the time at which the traffic is standing still at the intersection. Application of this information is used in: evaluating the efficiency of traffic regulation and control devices, developing proper timing sequences for traffic signals, determining the need for traffic signals, and calculating the costs for benefit-cost analyses of highway improvements.

Data Collected July 26, 1978

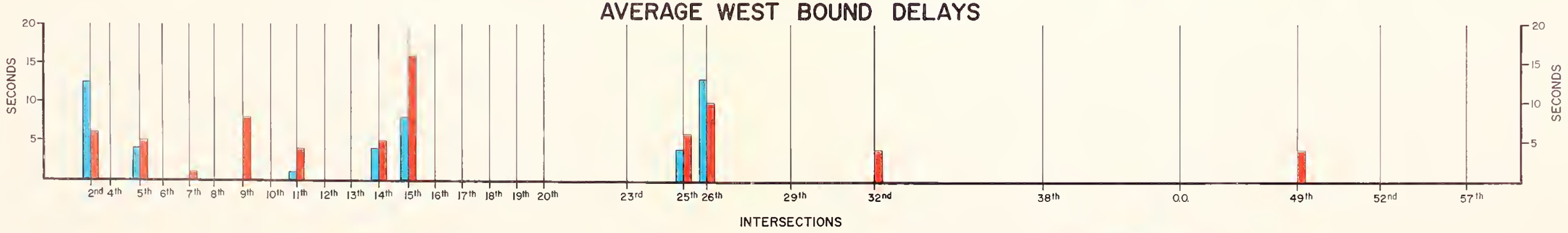
10TH AVENUE SOUTH – GREAT FALLS



AVERAGE WEST BOUND TRAVEL SPEEDS



AVERAGE WEST BOUND DELAYS



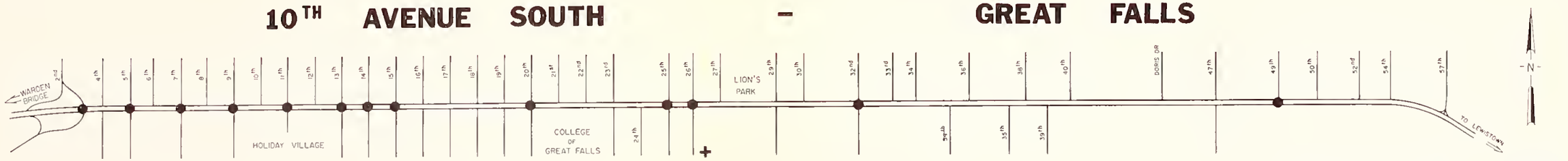
OFF-PEAK

PEAK

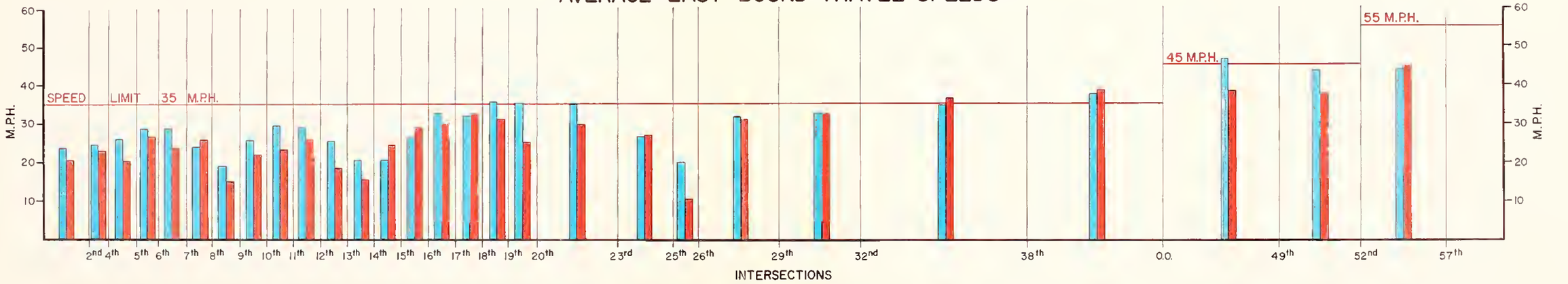
FIGURE 5

Data Collected July 26, 1978

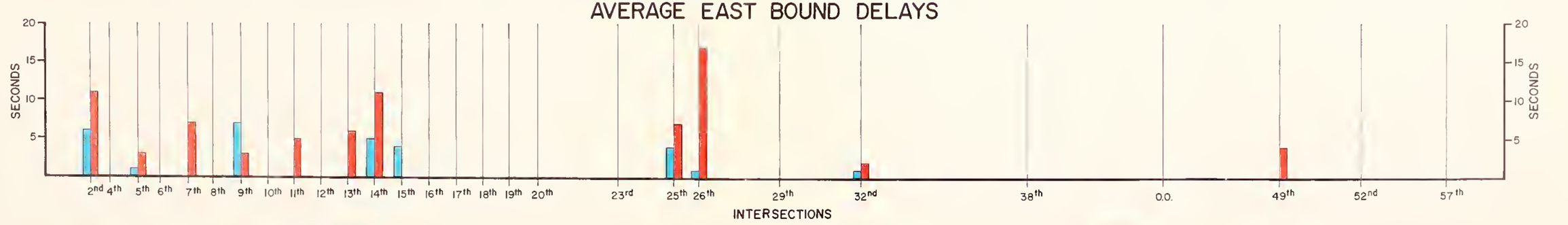
10TH AVENUE SOUTH - GREAT FALLS



AVERAGE EAST BOUND TRAVEL SPEEDS



AVERAGE EAST BOUND DELAYS



OFF-PEAK

PEAK

FIGURE 6

Intersection delay studies should be performed during periods of traffic congestion because excessive delays generally occur during peak traffic periods. The manual method used for this study involves counting the number of vehicles that are stopped in the intersection approach at successive intervals. The information required is the number of vehicles stopped in the approach, and the approach volume with both the number of approach vehicles stopping and not stopping being recorded.

(2) Tenth Avenue South Intersection Delay Study

Intersection delay studies were done at the 13 signalized intersections on Tenth Avenue South. The test consisted of counting the number of approach vehicles, the number of approach vehicles that had to stop, and the number of vehicles stopped in the approach at successive intervals of 15 seconds. These counts were taken on the approach traffic for all four legs of each intersection observed for ten-minute time periods during peak hour traffic.

The information collected is shown in Figures No. 7 and 8, and includes average delay per approach vehicle, average delay per stopped vehicle, and the percent of approach vehicles that stopped at the intersection. Additional detailed information including field sheets are available in computation reports on file at the Montana Department of Highways, Planning and Research Bureau in Helena.

(3) Summary of Results

For traffic on Tenth Avenue South, it is noted that the average delay for stopped vehicles varies from 15 to 30 seconds except for the west approach at 15th Street and the east approach at 2nd Street. The delay for the west approach to 15th Street is due to the large number of vehicles making a left turn on 15th Street (U.S. 87) causing delay of the traffic flow on Tenth Avenue South. The delay for the east approach to 2nd Street is due to the bottleneck effect of the two-lane Warden Bridge, and the resulting traffic backup through 2nd Street. The wide variation of average delays for approach vehicles is due to the fluctuation of side street approach volumes and the characteristics of the traffic signals at each intersection.

For traffic on north and south street approaches, delays vary from about 20 to 50 seconds for the most part, and are a function of the approach traffic volume and the amount of traffic signal green time allocated to the specific approach. None of the side street approach delays appear to be excessive.

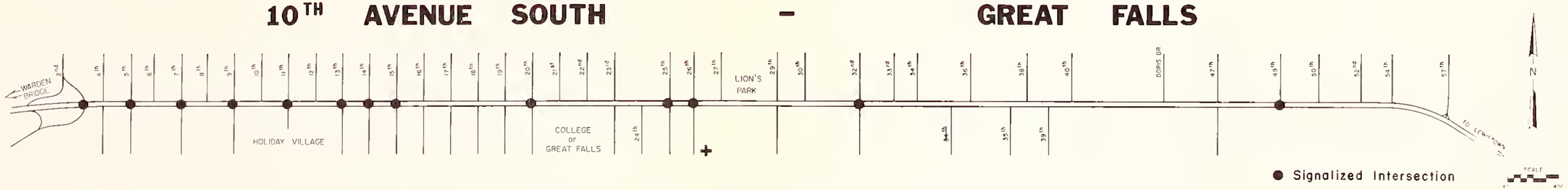
E. ACCIDENT STUDIES

(1) Intent of Accident Studies

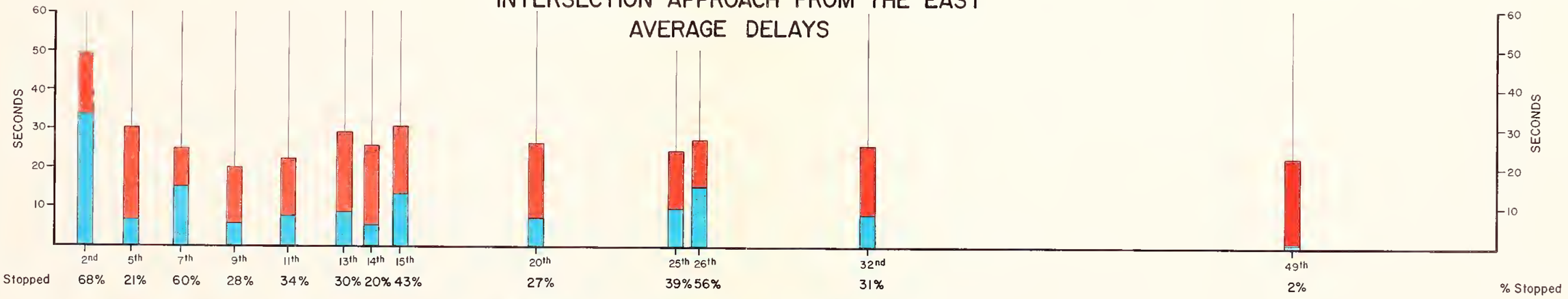
Accident studies are done to determine if the number of accidents that occur on a particular section of roadway can be reduced by the application of good roadway design features or by the application of proper traffic control devices. Accident records aid in defining and identifying high accident locations, to evaluate improvements by before-and-after studies, to justify the installa-

Data Collected In August 1978

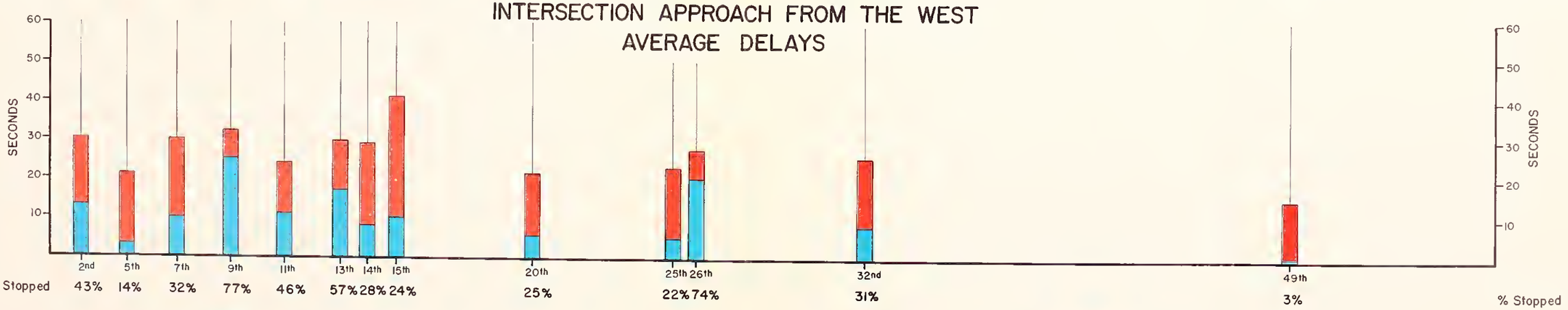
10TH AVENUE SOUTH - GREAT FALLS



INTERSECTION APPROACH FROM THE EAST
AVERAGE DELAYS



INTERSECTION APPROACH FROM THE WEST
AVERAGE DELAYS



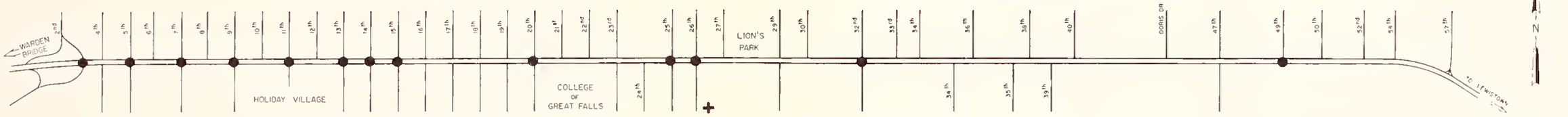
Average Delay Per Stopped Vehicle

Average Delay Per Approach Vehicle

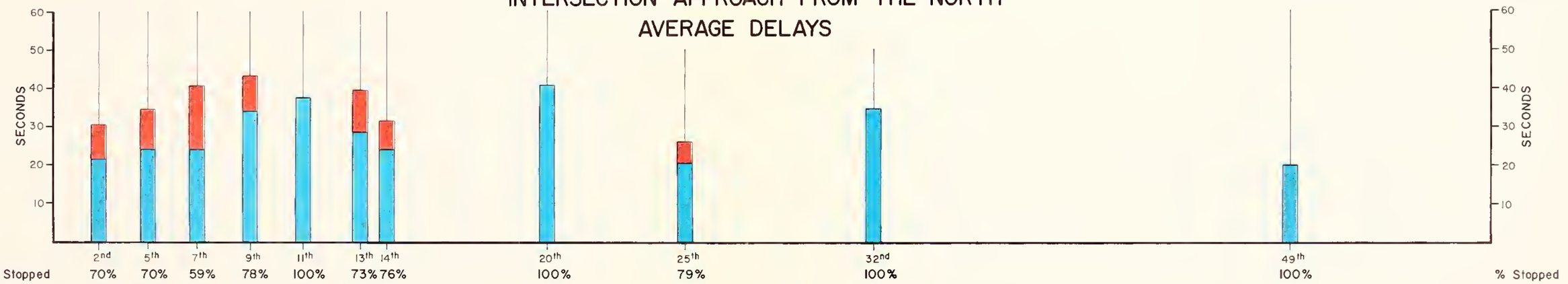
FIGURE 7

Data Collected In August 1978

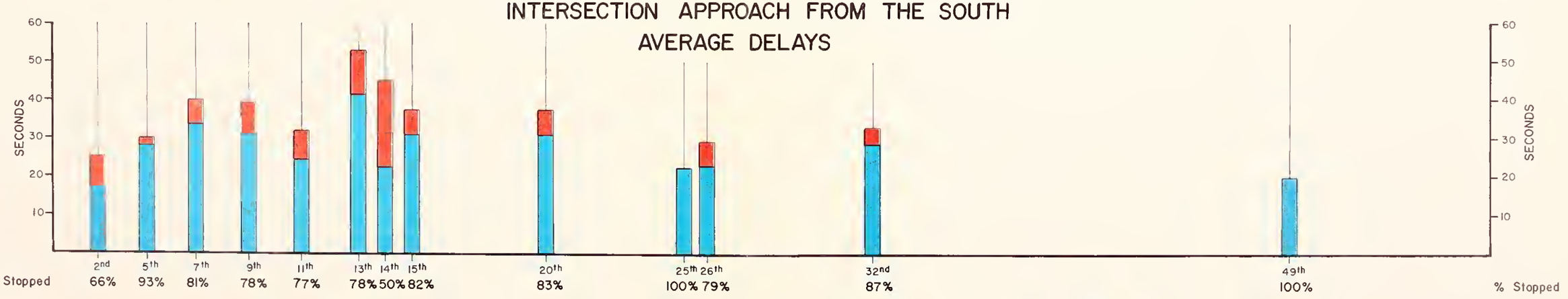
10TH AVENUE SOUTH - GREAT FALLS



INTERSECTION APPROACH FROM THE NORTH
AVERAGE DELAYS



INTERSECTION APPROACH FROM THE SOUTH
AVERAGE DELAYS



Average Delay Per Stopped Vehicle

Averoge Deloy Per Approoch Vehicle

FIGURE 8

tion or removal of traffic control devices, to aid in evaluating geometric designs, to establish priority listings for improvements, and to determine the need for improved street lighting.

(2) Accident Studies Conducted

The Great Falls Police Department maintains a record of all reported accidents in the city. A search of the accident record file was made and collision diagrams prepared for all accidents that occurred on Ninth Avenue South, Tenth Avenue South, and Eleventh Avenue South for the two years of 1976 and 1977. These accident records and collision diagrams are contained in a computation report and are on file at the Department of Highways, Planning and Research Bureau in Helena.

(3) Summary of Accident Studies

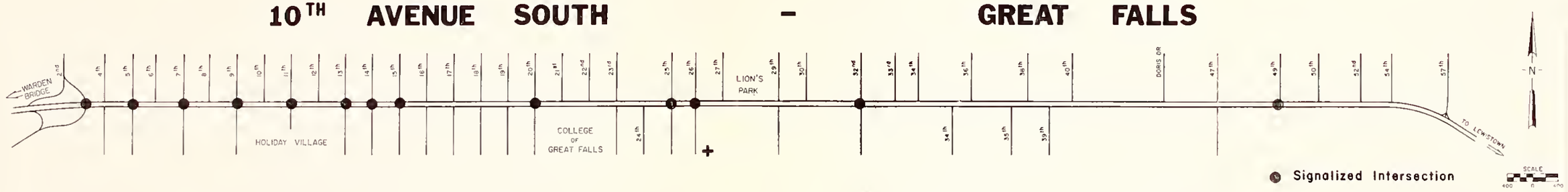
The total number of accidents occurring during this two-year period by type of accident is as follows:

Accident Type	Number
Property Damage	970
Personal Injury	93
Pedestrian Injury	1
Fatality	1
TOTAL	1,065

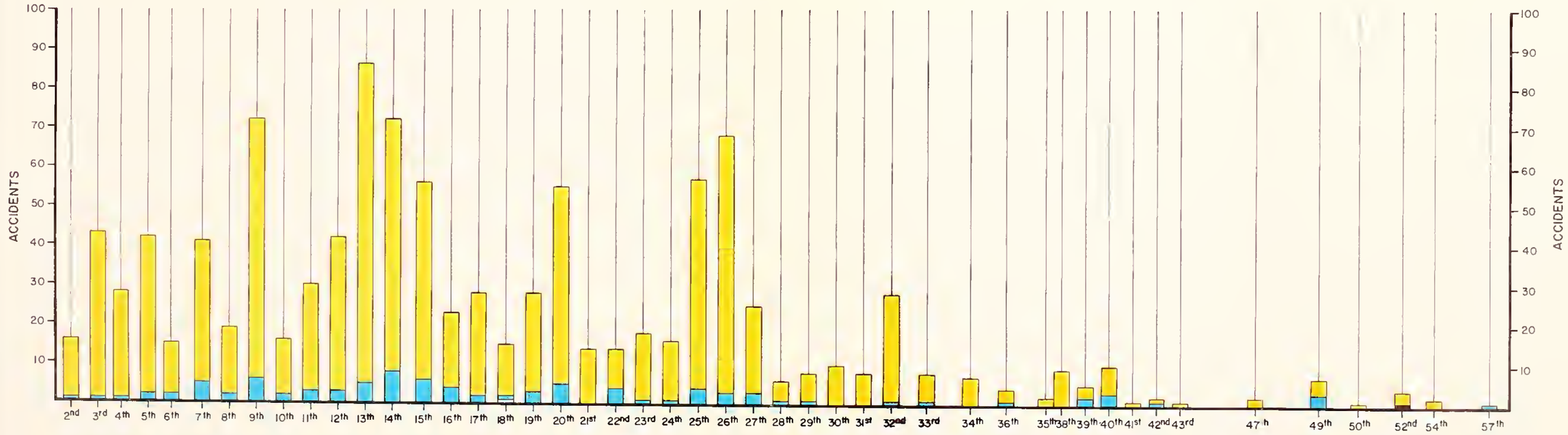
The pedestrian injury occurred at 18th Street where a large number of pedestrians cross Tenth Avenue South. The fatality occurred at 52nd Street. Of the total number of accidents, 73% occurred during the day and 27% occurred at night. However, the night-time accident rate is 1.95 accidents per 100,000 vehicle miles of travel (VMT) as compared with a daytime rate of 1.23 accidents per 100,000 VMT. Further information on the breakdown of daytime and night-time accident statistics is contained in Chapter IV - *Lighting System Analysis and Improvements*.

Figure No. 9, *Total Accidents in 1976 and 1977*, shows the number, location, and type of accidents that occurred on Tenth Avenue South in 1976 and 1977. An examination of this figure also shows a dramatically higher number of accidents from Warden Bridge to 28th Street than from 28th Street to 57th Street. The total number of accidents occurring from Warden Bridge to 28th Street is 945 for the two-year period as opposed to 120 accidents for the 28th Street to 57th Street section. These sections are nearly equal in length, but the western half of the study section has almost eight times as many accidents as the eastern half. When adjusted for traffic volumes and reduced to accident rates, the western half has a rate of 1.94 accidents per 100,000 VMT as compared to .43 accidents per 100,000 VMT for the eastern half of the study section.

10TH AVENUE SOUTH - GREAT FALLS



TOTAL ACCIDENTS IN 1976 & 1977



1976 - 506 - 48%

1977 - 559 - 52%

TOTAL - 1,065 100%

ACCIDENTS WITH PROPERTY DAMAGE

ACCIDENTS WITH INJURIES

ACCIDENTS WITH PEDESTRIAN INJURY

ACCIDENTS WITH FATALITY

FIGURE 9

PHOTOGRAPH NO. 1

PROPERTY DAMAGE ACCIDENT AT 4TH STREET INTERSECTION

PHOTOGRAPH NO. 2

EVIDENCE OF VEHICLE HITTING STREET LIGHT STANDARD IN MEDIAN AT 6TH STREET

The most logical explanations for this higher accident rate in the Warden Bridge to 28th Street section are that this section has more driveway accesses per block, has light poles in the median, has higher traffic volumes, has poorer pavement conditions, and has more traffic signals. It is of interest to note that the seven highest, and eleven of the twelve highest, accident locations occur at signalized intersections.

The highest accident rate in the 28th Street to 57th Street section occurs at 32nd Street. This is testimony that the off-set alignment of the north and south approaches of 32nd Street cause erratic driver maneuvers, and contributes to the cause of accidents. It is obvious that 32nd Street should be realigned to improve this situation and reduce the number of accidents.

F. PEDESTRIAN AND BICYCLIST STUDY

(1) Purpose of Study

A study of the pedestrians and bicyclists is required to evaluate the need for roadway facilities to accommodate these groups. Pedestrian and bicyclist data is used to determine the need and phasing for pedestrian heads at signalized intersections, to identify potential conflicts between motor vehicle travel and pedestrians and bicyclists, and to establish routes. Information considered in the study includes school zones and boundaries, pedestrian counts, jaywalker counts, an inventory of pedestrian facilities, bicyclist counts, and bicyclist facilities.

(2) Tenth Avenue South Pedestrian and Bicyclist Study

Pedestrian and bicyclist studies were conducted at two time periods, August 21st to 28th and September 11th to 27th. These studies reflect pedestrian and bicycle volumes and patterns just before and just after school started in the fall so that a comparison could be made. As a part of this study, the school district zone boundaries were reviewed. It was found that of the six school zones only one, the Longfellow School District, has boundaries that cross Tenth Avenue South. The Longfellow School District had stationed a school crossing guard at 9th Street in the past, but the school children pedestrian traffic was not sufficient to justify this action and the crossing guard was discontinued. A map of the school district boundaries and additional data on the pedestrian and bicyclist study are contained in a computation report on file at the Montana Department of Highways, Planning and Research Bureau in Helena.

The pedestrian and bicyclist counts were taken at twelve selected locations along Tenth Avenue South where the highest number of pedestrians was observed. Counts were taken from 7:30 a.m. to 10:30 a.m., 11:30 a.m. to 1:30 p.m., and 2:30 p.m. to 5:30 p.m. These count periods were considered to cover the eight peak hours of pedestrian travel. Count locations include 9th, 11th, 13th, 14th, and 15th Streets which is the Holiday Village Shopping Center area, 18th Street where a pedestrian accident occurred, 20th and 23rd Streets adjacent to the College of Great Falls, 25th and 26th Streets which constitute a high volume one-way couplet, and 27th and 29th Streets near the Lions Park.

(3) Results of Pedestrian and Bicyclist Study

Information collected for the pedestrian and bicyclist study is shown in Figure No. 10, *Pedestrian and Bicyclist Counts*. The total number of pedestrians per day counted in the *before* period (August 21st to 28th) was 1,916. This dropped to 1,476 in the *after* period (September 11th to 27th). In addition to the pedestrians, approximately 375 jaywalkers per day were counted in the *before* period and 242 jaywalkers counted in the *after* period. Bicyclist totals also dropped from 1,222 in the *before* period to 427 in the *after* period. A note is made of the exceptionally high pedestrian volume shown at 14th Street in the *before* count. This intersection is adjacent to the Holiday Inn and may have been due to a convention being held there at the time.

It is somewhat surprising that the number of pedestrians dropped significantly and the number of bikers dropped dramatically from the *before* school period to the *after* school period. This may be partially due to the school district boundaries terminating at Tenth Avenue South, and the school children therefore not being required to cross the street. An exception is at 20th Street near the college where pedestrian counts increased after school started. This is probably due to the college students crossing Tenth Avenue South to their apartments or to eating establishments (Burger King and McDonalds) on the north side of the street.

(4) Recommendations

During the inventory of pedestrian and bicyclist facilities, it was noted that most facilities are inadequate, in poor repair, or non-existent. In particular, it was noticed that some pedestrian heads were missing or non-functional cross-walks were not clearly signed, and sidewalks often blocked, inadequate, or non-existent.

Pedestrian volumes do not appear to be adequate to justify pedestrian overpasses or underpasses. However, it is recommended that proper equipment and facilities be provided to accommodate the pedestrians. These improvements would include well-lighted concrete sidewalks, high-visibility stripped cross-walks, and functioning pedestrian heads at the cross-walks.

In addition, a bike path is recommended on the north side of Tenth Avenue South from 57th Street to Doris Drive West, where sufficient right-of-way is available. From Doris Drive West, 9th Avenue should be designated as the bike route to avoid traffic conflicts due to the limited right-of-way. At 2nd Street, the bike route will connect up with the proposed bike path across Warden Bridge.

G. OFF-STREET TRAFFIC CIRCULATION AND PARKING STUDY

(1) Field Inventory

A field inventory was conducted of the parking lots and traffic circulation patterns and facilities existing on Tenth Avenue South in September, 1978. This inventory included parking lot locations, number of parking spaces per lot, the traffic circulation within the lot, curb inventory, number of driveways, and a review of the traffic flow patterns. Much of this information is recorded on Figure No. 20, *Photographic Plan View of Recommended Improvement Plan*, at the end of this report.

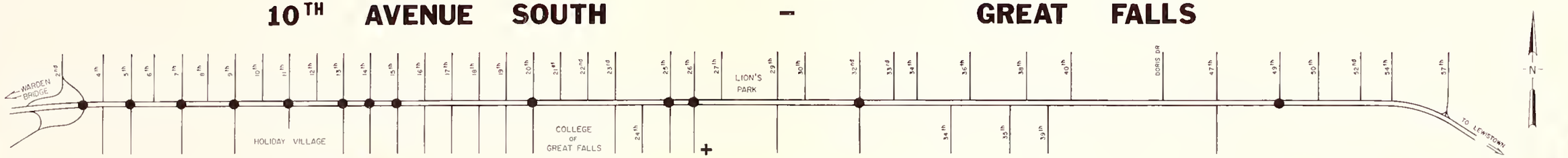
Table No. 1

PEDESTRIAN AND BICYCLIST COUNTS

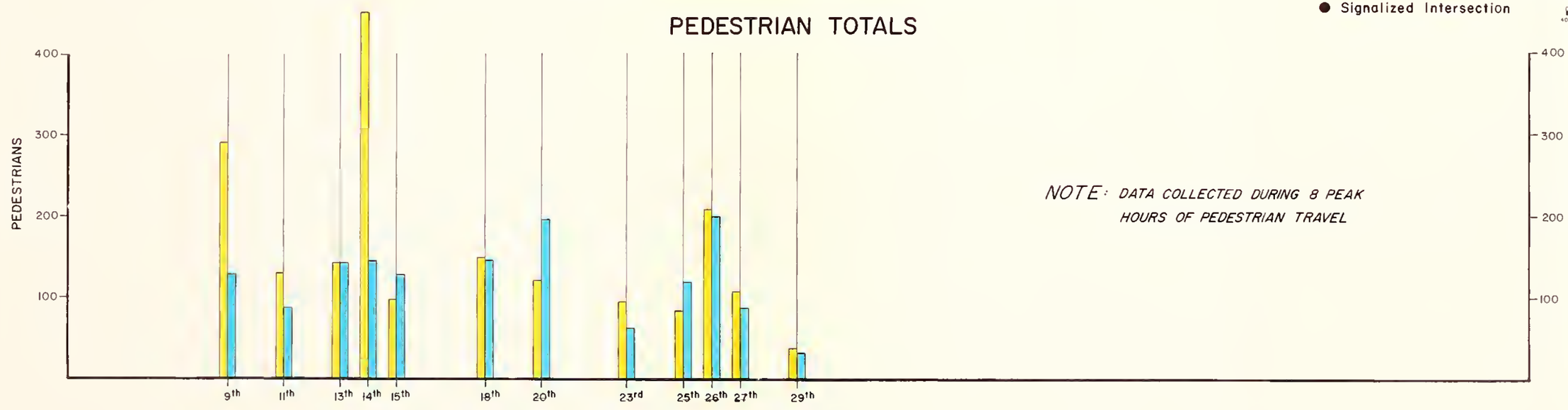
Intersection		PEDESTRIANS		BICYCLISTS		
		Crossing 10th Ave. South	Traveling Along 10th Ave. South	Crossing 10th Ave. South	Traveling Along 10th Ave. South	Pedestrians Crossing Mid-Block
9th	Before	159	132	109	95	-
	After	67	62	11	7	15
11th	Before	91	39	51	54	-
	After	51	36	4	3	7
13th	Before	64	79	33	44	-
	After	62	81	14	31	22
14th	Before	197	254	28	54	-
	After	65	80	13	35	27
15th	Before	49	48	30	55	25
	After	44	84	7	29	18
18th	Before	30	119	26	67	52
	After	61	85	19	28	23
20th	Before	56	66	43	64	27
	After	100	96	29	30	62
23rd	Before	19	76	18	57	24
	After	24	39	15	10	14
25th	Before	33	51	42	53	18
	After	39	80	11	18	12
26th	Before	66	142	31	77	41
	After	65	134	33	17	23
27th	Before	30	78	13	95	20
	After	24	63	17	24	10
29th	Before	9	29	30	53	17
	After	16	17	2	20	9
SUBTOTAL	Before	803	1,113	454	768	-
	After	618	857	175	252	-
TOTAL	Before	1,916		1,222		375 (Approx.)
	After	1,475		427		242

Note: Before counts collected on August 21 - August 28, 1978.
After counts collected on September 11 - September 27, 1978.
Hours Sampled: 7:30 a.m. - 10:30 a.m.
11:30 a.m. - 1:30 p.m.
2:30 p.m. - 5:30 p.m.

10TH AVENUE SOUTH - GREAT FALLS

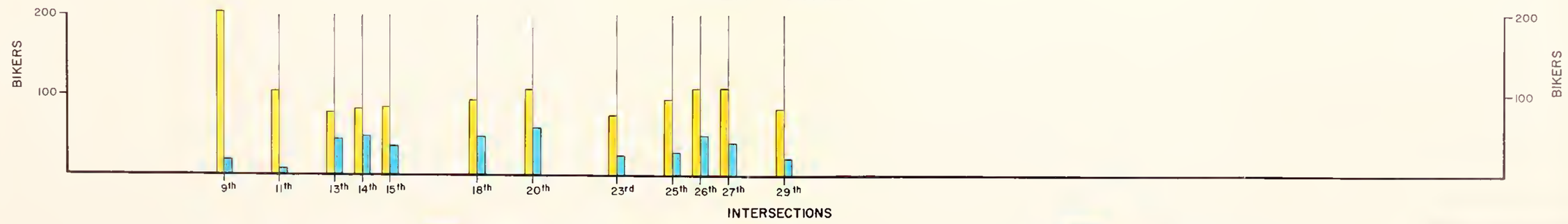


PEDESTRIAN TOTALS



NOTE: DATA COLLECTED DURING 8 PEAK HOURS OF PEDESTRIAN TRAVEL

BIKER TOTALS



BEFORE SEPTEMBER 1,1978

AFTER SEPTEMBER 1,1978

FIGURE 10

(2) Identification of Problems

The field inventory revealed a number of problems with the existing parking and traffic circulation facilities. One of these problems is the large number of driveway accesses to Tenth Avenue South that makes it difficult to predict vehicle maneuvers as they enter onto the street. This problem is discussed in detail in Chapter VIII - *Access Plan*.

Many of the businesses have built right on or very near to the highway right-of-way line. This does not provide sufficient parking area, and in many cases, highway right-of-way is used for parking. Traffic circulation is also impaired because the buildings that are built too close to the street do not provide for traffic circulation through parking areas.

There is an imbalance in the number of driveway accesses to the parking availability. In most cases, large parking areas have very few accesses and good traffic circulation, while small parking areas may have a number of driveway accesses and very poor traffic circulation. The smaller parking areas also show the greater number of infractions such as driving over curbs to get onto Tenth Avenue South, and blocking the sidewalk and highway with parking vehicles.

(3) Improvements Recommended

To consolidate traffic movements and for drivers to anticipate side street traffic, it is recommended that as much traffic as possible be channeled to side streets before accessing on Tenth Avenue South. Driveway accesses and infractions such as driving over the curb should be limited as much as possible. If driveway accesses are permitted, they should not be located near intersections.

Businesses should be encouraged to consolidate parking, and to provide fewer and larger areas to meet the parking needs. Large parking lots are easier to manage and lend themselves to better traffic circulation patterns.

CHAPTER VI

PAVEMENT ANALYSIS AND IMPROVEMENTS

A. DISCUSSION OF PROBLEMS

B. PAVEMENT AND SUBGRADE EVALUATION REPORTS

C. TEST BORINGS

D. LABORATORY INVESTIGATIONS

E. SUBGRADE EVALUATION

F. PAVEMENT SECTION EVALUATION

G. RECOMMENDED IMPROVEMENTS

CHAPTER IV
LIGHTING SYSTEM ANALYSIS AND IMPROVEMENTS

A. BENEFITS OF GOOD STREET LIGHTING

A number of studies relating to street lighting have consistently demonstrated that good street lighting is a valuable aid to law enforcement agencies, contributes to community pride, and is a deterrent to crime and vandalism. Roadway lighting is generally accepted to be an important contributor to safe and efficient traffic operations. Studies relating to roadway lighting and accident frequency have consistently demonstrated that a reduction in personal injury accidents in the order of 30% are realized when roadways previously poorly illuminated were relighted to modern standards. For these and other associated reasons, it has been concluded that adequate street and highway lighting is justified by the resulting benefits, both tangible and intangible.

B. DESIGN CRITERIA

The American Association of State Highway and Transportation Officials publishes a report on lighting entitled *An Informational Guide For Roadway Lighting*. Design standards and criteria for both freeways and streets and highways other than freeways are contained in this report. This report also states that the elements of street and highways such as at-grade intersections, turning movements, signalization, parking, and pedestrian traffic are operating characteristics where the value of roadway lighting has been demonstrated.

Levels of illumination as recommended by AASHTO are contained in Table No. 1, *Average Maintained Illumination for Streets and Highways Other Than Freeways*. In addition to the recommended levels for illumination, this report recommends a maximum uniformity of illumination ratio (ratio of average footcandles of illumination on the pavement area to the footcandles at the point of minimum illumination) of 3:1 to 4:1. It is also noted that intersections with raised divisional islands may require somewhat greater illumination.

C. EXISTING STREET LIGHTING SYSTEM

The existing street lighting system on Tenth Avenue South consists of two different luminaire types and light standard heights. From the Warden Bridge to 28th Street and from 34th Street to 38th Street, roadway lighting is provided by 400-watt mercury vapor luminaries mounted on light standards 25 feet high spaced at 130 feet apart. These light standards are located in the median. From 28th Street to 34th Street and from 38th Street to 57th Street, roadway lighting is provided by 400-watt high pressure sodium vapor luminaries mounted on light standards 35 feet high spaced at 220 feet. These light standards are located outside of the roadway behind the sidewalk.

Table No. 1

AVERAGE MAINTAINED ILLUMINATION FOR STREETS AND HIGHWAYS OTHER THAN FREEWAYS

Roadway Classification	Average Maintained Horizontal Footcandles*		
	Area Classification		
	Downtown	Intermediate	Outlying and Rural
Major**	2.0	1.4	1.0
Collector	1.2	0.9	0.6
Local or Minor	0.9	0.6	0.2***

* Average illumination on the traveled way or on the pavement area between curblines of curbed roadways, when the illuminating source is at its lowest output and when the luminaire is in its dirtiest condition.

** Includes expressways with partial control of access. Expressways with full control of access are covered in the section on freeways.

*** Includes residential streets.

Source: AASHTO, *An Informational Guide for Roadway Lighting.*

D. LIGHTING SYSTEM ANALYSIS

Light meter readings were taken at several locations on both roadway lighting systems using a General Electric horizontal footcandle light meter owned by the Department of Highways. The locations where readings were taken and a summary of the results are as follows:

Table No. 2

LIGHT METER READINGS ON TENTH AVENUE SOUTH

Location	Luminaire Type	Pole Height	Pole Spacing	Horizon. Ft. Can.	Uniformity Ratio
13th Street to 14th	400-Watt Mercury Vapor	25′	130′	.91	3.2:1
21st Street to 22nd	400-Watt Mercury Vapor	25′	130′	1.49	3.3:1
29th Street to 30th	400-Watt High Pressure Sodium Vapor	35′	220′	4.35	2.4:1
Doris Dr. to 50th St.	400-Watt High Pressure Sodium Vapor	35′	175′	4.35	2.2:1

It can be noted from this summary that the 400-watt mercury vapor luminaries are deficient when compared to the AASHTO recommended design criteria, while the 400-watt high pressure sodium vapor luminaries far exceed the recommended standards.

E. ACCIDENT ANALYSIS

Accident records for Tenth Avenue South were analyzed to determine if the different lighting systems showed a marked variation in accident rates. Caution was exercised to separate daytime and night-time accidents for each section of roadway so that the effect of geometric differences would not unduly influence the accidents due to the differences in roadway lighting. To simplify the process, the accidents were categorized from Warden Bridge to 28th Street and from 28th Street to 57th Street. Following are tabulations showing the accident statistics.

Table No. 3

ACCIDENTS AND ACCIDENT RATES

Total Accidents

	2-Year Total	Warden Bridge to 28th Street	28th Street to 57th Street
Daytime	774	695	79
Night-time	291	250	41
Total	1,065	945	120

Average Traffic Volumes (AADT)

	Warden Bridge to 28th Street	28th Street to 57th Street
Daytime	24,323	14,594
Night-time	5,937	3,562
Total	30,260	18,156

Accident Rates (Per 100,000 Vehicle Miles of Travel)

	10th Ave. South	Warden Bridge to 28th Street	28th Street to 57th Street
Daytime	1.23	1.78	.35
Night-time	1.95	2.62	.75
Total	1.40	1.94	.43

It can be noted that there is a substantial difference in the accident rates between the two sections of roadway analyzed. Much of the occurrence of the higher accident rates for the Warden Bridge to 28th Street section as opposed to the 28th Street to 57th Street section can be attributed to the difference in geometrics. However, it is noted that the difference between daytime and night-

time accident rates is .84 accidents/100,000 VMT for the Warden Bridge to 28th Street section, and .40 accidents/100,000 VMT for the 28th Street to 57th Street section. The lower difference between the night-time to daytime accident rates for the 28th Street to 57th Street section can be directly attributed to the much more effective high pressure sodium luminaries that have been installed on this section.

In addition to the difference in accident rates found between the mercury vapor luminaries and the sodium vapor luminaries, it has been observed that a number of accidents are caused by vehicles hitting light standards that are placed in the median. According to Montana Power Company records, from 20 to 30 percent of the median light standards are hit and some 20 to 25 standards are completely destroyed and require total replacement each year. Light standards that are placed outside of the roadway are seldom hit, and rarely have to be replaced.

F. RECOMMENDED IMPROVEMENTS

It has been demonstrated in the previous discussions that the high pressure sodium vapor luminaries mounted on standards outside of the roadway provide much more effective street lighting, result in a significantly lower accident rate, and require much less maintenance than the mercury vapor lights mounted on standards in the median. In addition to these other benefits, the high pressure sodium luminaries are much more energy efficient and may save as much as 50% in energy costs over the mercury vapor luminaries.

In light of these benefits, it is recommended that the 400-watt mercury vapor luminaries mounted on standards in the median be replaced with 400-watt high pressure sodium vapor luminaries mounted on standards outside of the roadway.

CHAPTER V

DRAINAGE SYSTEM ANALYSIS AND IMPROVEMENTS

A. STORM DRAINAGE CONSIDERATIONS

B. REVIEW OF STORM DRAIN PLAN FOR GREAT FALLS

C. DRAINAGE PROBLEMS

D. COORDINATION WITH PROPOSED
STORM DRAIN IMPROVEMENTS

CHAPTER V
DRAINAGE SYSTEM ANALYSIS AND IMPROVEMENTS

A. STORM DRAINAGE CONSIDERATIONS

In the evaluation of the storm drainage system for Tenth Avenue South, several factors influencing the effect of the storm drainage system must be considered. The first consideration that influences the evaluation is that storm waters from Tenth Avenue South are diverted into several storm drain systems in different drainage basins. Therefore, the storm drain system evaluation cannot be concerned only with Tenth Avenue South, but must consider the effect on all of the systems. Other factors influencing the removal of storm waters include cross-grade on pavement, longitudinal grade of street curb and gutter, rutting and depressions in the pavement, number and location of storm drain inlets, and drainage from side streets.

B. REVIEW OF STORM DRAIN PLAN FOR GREAT FALLS

In 1972, the consulting engineering firm of Black and Veatch prepared an *Areawide Sanitary and Storm Sewerage Facilities Plan for the Great Falls Planning Area*. The conclusions and recommendations of this study were combined with a detailed field inventory to form the basis of analysis for the storm drain systems on Tenth Avenue South.

It is particularly noted that improvements to storm sewer trunk lines are required to provide adequate capacity to drain storm waters on the west end of Tenth Avenue South from 2nd Street to 19th Street. Without these improvements that are proposed in the storm drain plan, it is doubtful that the storm drain trunk lines will have sufficient capacity to drain Tenth Avenue South.

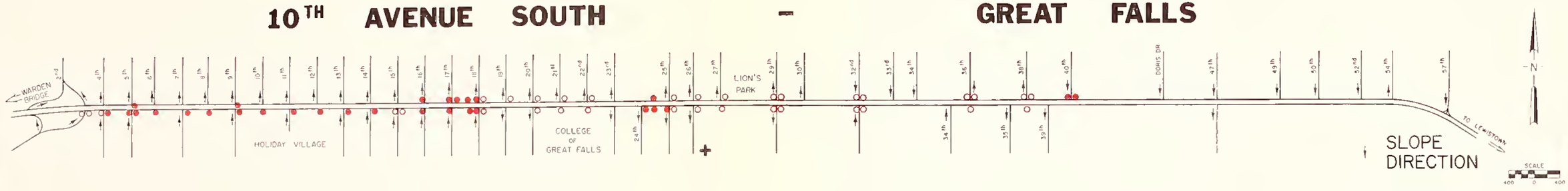
C. DRAINAGE PROBLEMS

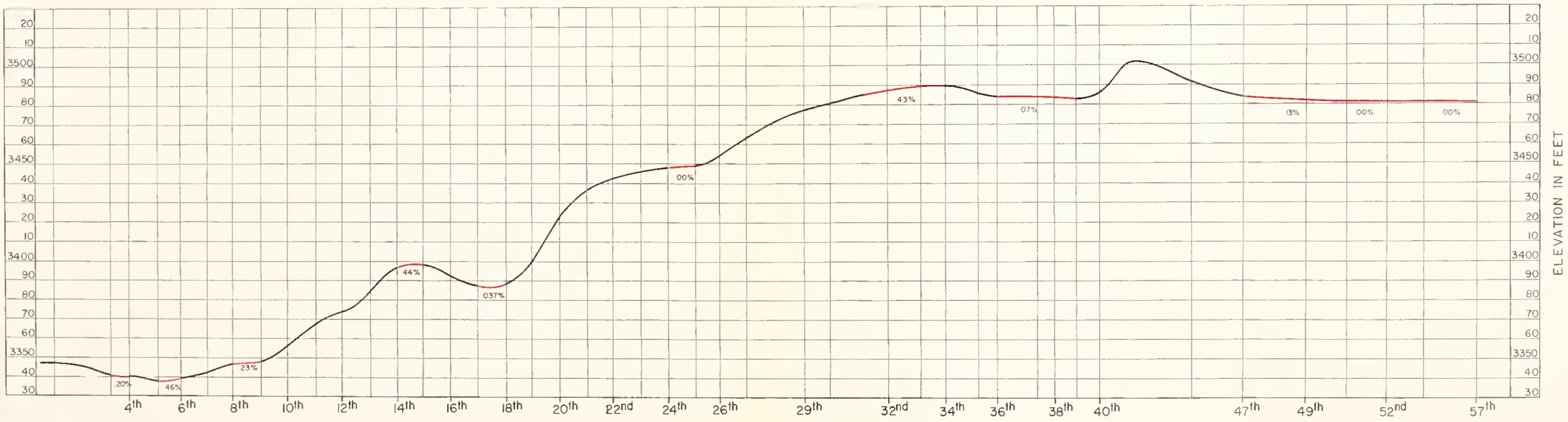
During periods of runoff, the most obvious problem with drainage that is evident to the motorist is that ponds form in ruts and depressions in the pavement, particularly at intersections and along the curb line. Ruts and depressions in the pavement are caused when deteriorated pavement is replaced with a softer road mix. The road mix deforms under the heavy traffic load of Tenth Avenue South and forms the ruts and depressions.

The recommended minimum grade to provide proper drainage in paved roads is .5%. A review of the profile grade of Tenth Avenue South revealed several areas that averaged from less than .5% grade to a flat grade. These grades are not sufficient to properly drain storm water, and ponding on the street is the result. Figure No. 11 shows the street profile and areas where the vertical grade is less than the recommended minimum.

An inventory was made of the location of existing storm drain inlets along Tenth Avenue South. Of particular concern were those areas that had inadequate slope and where ponding was occurring at the intersections. A total of 34 additional storm drain inlets and required laterals to provide connections to an existing storm drain system are recommended. On the east end of the pro-

10TH AVENUE SOUTH - GREAT FALLS





ROAD PROFILE

FIGURE 11

ject, a surface drainage scheme is proposed until the density of development requires a storm drain system. Figure No. 12 shows the major existing storm drain systems that are affected by Tenth Avenue South, and the recommended improvements.

E. COORDINATION WITH PROPOSED STORM DRAIN IMPROVEMENTS

At the present time, Great Falls has under consideration proposed improvements to storm drain systems that service Tenth Avenue South. It is important that these systems are established and coordinated with the improvements proposed for Tenth Avenue South, so that duplication of facilities or inadequate facilities are not installed. It is recommended that a detailed storm drain analysis is done for each drainage basin prior to design to avoid these problems.

PHOTOGRAPH NO. 3
PONDING AT 15TH STREET INTERSECTION DUE TO LACK OF A STORM DRAIN INLET

PHOTOGRAPH NO. 4
PONDING IN GUTTER DUE TO INADEQUATE
LONGITUDINAL DRAINAGE AT 38TH STREET

PHOTOGRAPH NO. 5
SPRING ENTERING BASE OF ROADWAY AT
FOURTH STREET CAUSING SATURATED SUBGRADE

10TH AVENUE SOUTH DRAINAGE SYSTEM IMPROVEMENTS

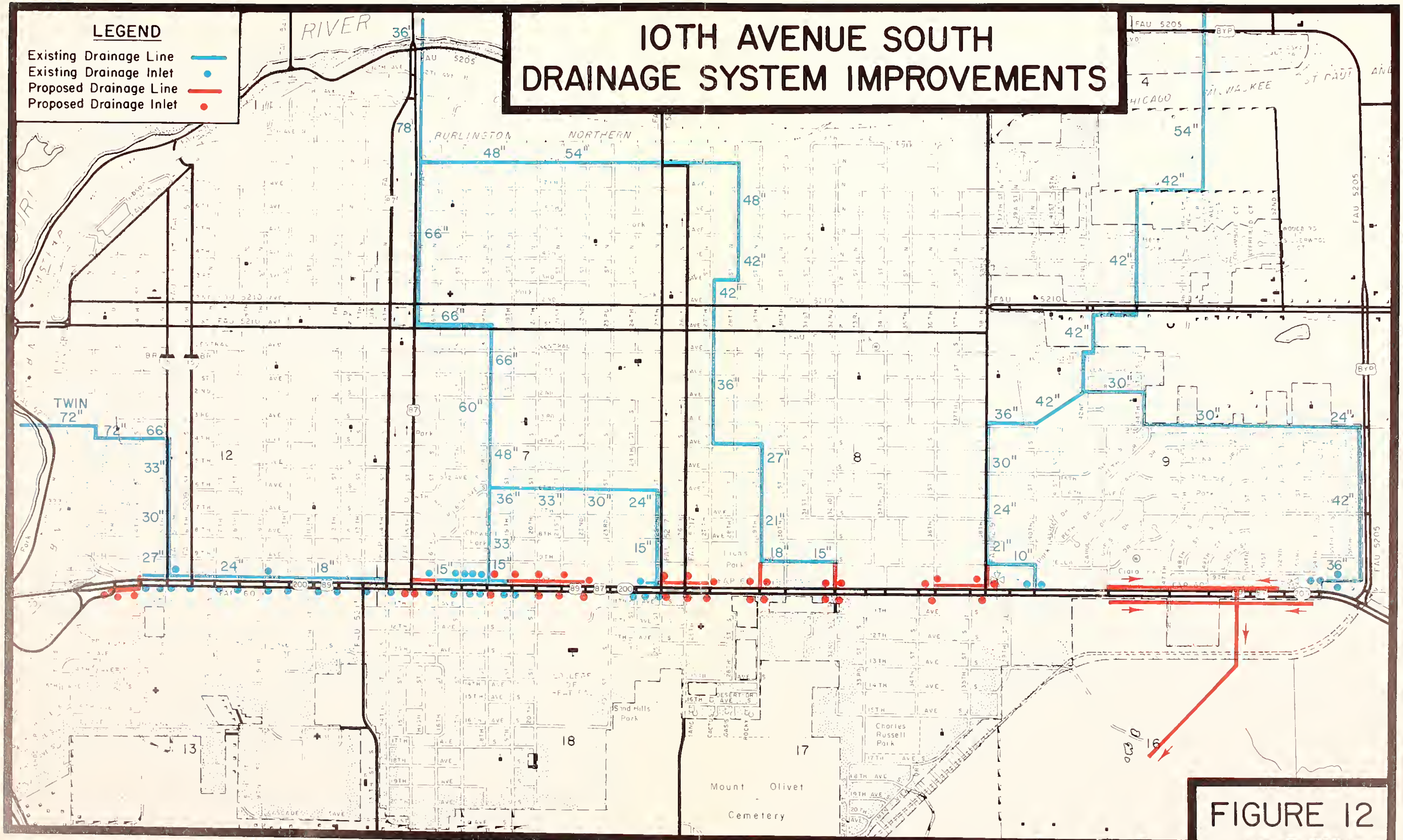


FIGURE 12

CHAPTER VI

PAVEMENT ANALYSIS AND IMPROVEMENTS

A. DISCUSSION OF PROBLEMS

B. PAVEMENT AND SUBGRADE EVALUATION REPORTS

C. TEST BORINGS

D. LABORATORY INVESTIGATIONS

E. SUBGRADE EVALUATION

F. PAVEMENT SECTION EVALUATION

G. RECOMMENDED IMPROVEMENTS

CHAPTER VI
PAVEMENT ANALYSIS AND IMPROVEMENTS

A. DISCUSSION OF PROBLEMS

The pavement on Tenth Avenue South is prone to severe breakup in the spring. This breakup results in cracked pavement and chuckholes that can cause damage to vehicles, and may be a contributing cause to accidents as well as being an inconvenience to the motorist. Many complaints have been lodged with regard to the pavement condition, and this situation has been the subject of a number of articles in the Great Falls newspaper.

In addition to the more obvious problem of spring breakup, the pavement shows signs of severe rutting and shoving. This renders the pavement surface difficult to drive on, and makes it difficult to maintain legible and safe pavement markings (see Photograph No. 7). It was evident from the problems associated with the pavement that a detailed field investigation by a qualified soils engineer would be required to pinpoint the exact problems and to determine recommended solutions.

B. PAVEMENT AND SUBGRADE EVALUATION REPORTS

The consulting firm of Northern Testing Laboratories of Great Falls was requested to conduct soils borings and selected laboratory investigations on the pavement section. Northern Testing Laboratories conducted the soils borings and performed the laboratory investigations in September of 1978. The results of their tests and the report prepared by them is contained in the Tenth Avenue South Improvement Plan - Supplemental Report.

C. TEST BORINGS

Test borings were made at four locations to obtain information on the existing surfacing and subgrade conditions, and the engineering properties of the existing materials and subsoil. The test borings were located on Tenth Avenue South at the following intersections: (1) 3rd Street South, (2) 10th Street South, (3) 17th Street South, and (4) 26th Street South. The location of the test holes and the results of these borings are shown in Figure No. 13.

D. LABORATORY INVESTIGATIONS

Samples obtained from the field investigations were inspected in the laboratory, classified, and tested to determine the engineering and physical properties of the soil. Tests that were done included: grain size distribution, atterberg limits, natural moisture content, moisture-density relationships, California Bearing Ratios, density and thickness of asphalt cores, asphalt extraction and gradation tests, remolded Marshall properties tests, and retained asphalt cement tests.

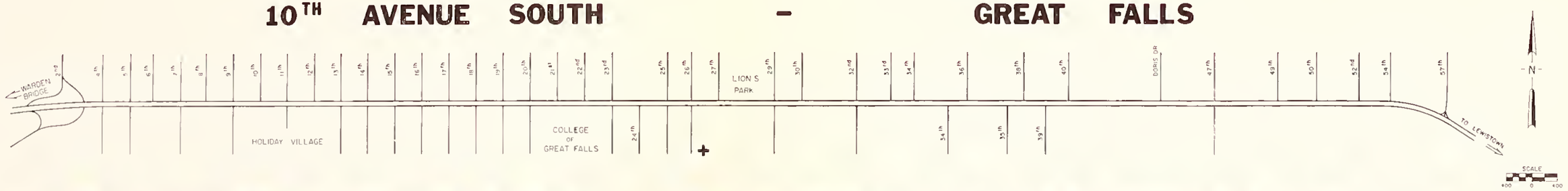
The results of these tests are also contained in the Tenth Avenue South Improvement Plan - Supplemental Report.

PHOTOGRAPH NO. 6
DRILLING RIG IN THE PROCESS OF BORING TEST HOLES FOR PAVEMENT AND SUBGRADE ANALYSIS

PHOTOGRAPH NO. 7
DEFORMATION OF PAVEMENT DUE TO INADEQUATE STABILITY AND HEAVY TRAFFIC LOADS AT 11TH STREET

Data Collected October 2,1978

10TH AVENUE SOUTH - GREAT FALLS



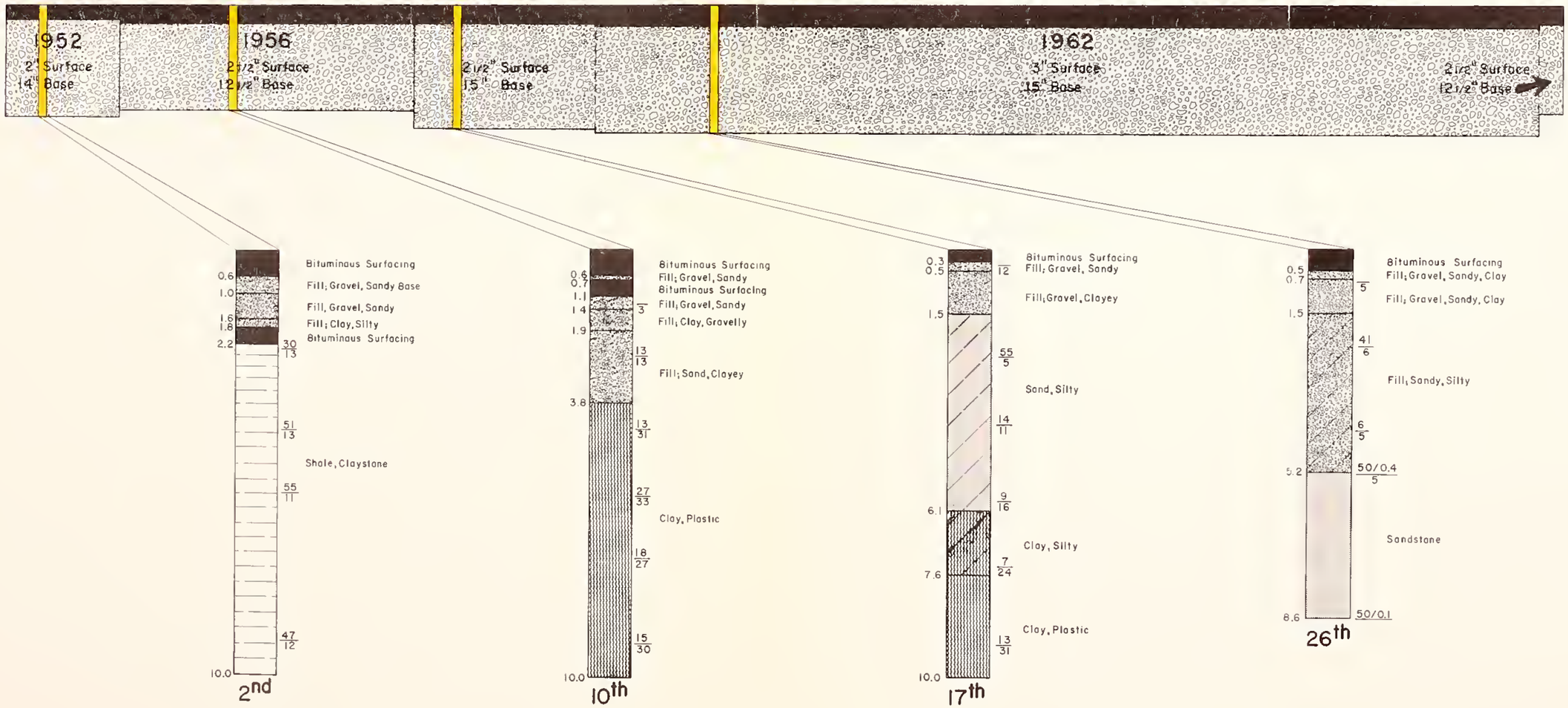


FIGURE 13

E. SUBGRADE EVALUATION

The subgrades in the sections studied are composed of three major subgrade types: weathered claystone, plastic or silty clay, and fine silty sand (blowsand). The claystone weathers rapidly and slakes to a sandy or silty clay soil, and the properties of the decomposed shale may be considered similar to those of the silty or plastic clay. The California Bearing Ratio tests that were conducted showed that gravel mixed in any quantity with the soils will appreciably increase the support properties of all of the soils.

The soils consultants' experience with the uncontaminated natural soils in the area indicated that a subgrade support value of CBR=2% is applicable for silty and plastic clay and decomposed shale, and a value of CBR=7% is applicable for silty sand (blowsand). These values were used to evaluate the existing pavement sections and for preliminary design of recommended pavement sections.

F. PAVEMENT SECTION EVALUATION

The existing structural section for the pavement is composed of a granular base course and a bituminous surface course. Original pavement sections and the date of construction were obtained from the Montana Department of Highways Federal Aid Road Log. At the time of the investigation, however, most of the intersection areas where tests were taken have been patched with a bituminous roadmix overlay and bore little resemblence to the original sections. Figure No. 13 shows the pavement sections as recorded in the Federal Aid Road Log and the pavement sections that were actually found to exist in place.

The granular base course is of very poor quality. Whether by contamination from the subgrade, degradation of the base course material itself, or because of original quality, the base course gravel is too rounded and contains far too much minus 200 mesh material (silt and clay) and is too plastic to be considered a quality granular base for support of heavy traffic. The detrimental low-saturated strength of the silt-clay fraction within the gravel is made even more critical since there is considerable evidence of poor drainage which results in high moisture content in the base course. Through the section surfaced in 1962 as shown in Figure No. 13, it might be possible to utilize the existing granular material in a surfacing section, but it could only be considered as a sub-base material.

Full depth surfacing section requirements were calculated according to current American Asphalt Institute criteria using the subgrade support values and the current traffic volume. These sections were then compared with the equivalent existing pavement section to determine if the existing pavement section was inadequate. The Preliminary Subgrade and Pavement Evaluation Report contained in the Tenth Avenue South Improvement Plan - Technical Supplement contains the complete analysis and indicates the section inadequacies. The results are summarized for each test hole as follows:

Test Hole No. 1 - Third Street South (claystone shale subgrade). This pavement section is lacking 14 inches of uncrushed base course or 5 inches of asphalt concrete surfacing to support the existing traffic volume.

Test Hole No. 2 - Tenth Street South (clay subgrade). This pavement section is lacking 12.3 inches of uncrushed base course or 4.5 inches of asphalt concrete surfacing to support existing traffic.

Test Hole No. 3 - Seventeenth Street South (sand subgrade). This pavement section is lacking 1.1 inches of asphalt concrete surfacing and 0.7 inches of uncrushed base course, or 1.4 inches of asphalt concrete surfacing to support existing traffic.

Test Hole No. 4 - Twenty-Sixth Street South (sand subgrade). This pavement section is essentially adequate to support the existing traffic.

This equivalency concept method of analysis may be misleading in that there are certain problems that are not considered and are not resolved by this method of analysis. In particular, the replacement of the original bituminous surfacing with several generations of road mix and *half-sole* does not retain the physical properties required for heavy truck loading. In addition, the original pavement left in place is contaminated and softened by the cutback asphalt in the road mix. The softer road mix asphalt and contaminated original asphalt is evidenced by the severe amount of rutting and shoving now observed in the pavement. This problem cannot be resolved by just overlay, since the soft layer would still be present within the zone of influence of the imposed wheel loads.

Another problem is the gravel *sandwich* sections found at 3rd Street and 10th Street, where the granular base material is sandwiched between two layers of bituminous surfacing. It is generally accepted that this condition will usually result in failure under heavy traffic due to moisture entrapment between the two bituminous layers.

G. RECOMMENDED IMPROVEMENTS

On the basis of these soils borings and laboratory investigations, it has been determined that: (1) the pavement section from Warden Bridge to 17th Street is totally inadequate and will have to be reconstructed; (2) the pavement section from 17th Street to 28th Street is inadequate but some of the pavement section may be salvageable; (3) from 28th Street to 57th Street, the pavement section has a probable remaining life of from five to ten years.

CHAPTER VII

TRAFFIC SIGNAL SYSTEMS

A. EXISTING TRAFFIC SIGNAL SYSTEM

B. ANALYSIS OF EXISTING SYSTEM OPERATION

C. PROPOSED SYSTEM DEVELOPMENT

D. INTERSECTION ANALYSIS

E. NEW TRAFFIC SYSTEMS - STATE OF THE ART

CHAPTER VII
TRAFFIC SIGNAL SYSTEMS

A. EXISTING TRAFFIC SIGNAL SYSTEM

The existing traffic signal control system on Tenth Avenue South was installed in 1964. The original system consisted of a TM-1 traffic adjusted master controller at 9th Street with T-517 two-phase semi-actuated traffic controllers and TM-24 coordination units, located at 2nd Street, 5th Street, 7th Street, 9th Street, 11th Street, 13th Street, 14th Street, and 15th Street. G-2 advance green timers were installed at the intersections at 2nd, 9th, and 15th Streets to provide leading left-turn movements on a fixed time basis.

The timing for the side street approaches onto Tenth Avenue South is dependent on MR-10 magnetic vehicle detectors. If there are no vehicles detected or pedestrian push button actuation, the green signal would be continuously displayed on the arterial.

Subsequently, the intersections of 20th, 25th, 26th, and 32nd and 49th Streets have been signalized with all but 49th Street added to the coordinated system. An advance green timer has been added to 13th Street.

Interconnection is accomplished by No. 10 conductor cable in underground conduit from 2nd Street to 15th Street, and via telephone interconnect to 20th, 25th, and 26th and 32nd Streets.

The system is known as a traffic adjusted system. It has the ability to provide three cycle lengths with three offsets per cycle. The offsets provide either inbound progression, outbound progression or average progression on each cycle. The three cycle lengths installed are 60 seconds, 70 seconds, and 80 seconds.

Selection of cycle length and offset is made by the TM-1 Master Coordinator based on volume sampling detectors on Tenth Avenue South and parameters set on the TM-1. These detectors are located between 9th and 10th Streets and also at 25th Street. When the volumes drop below present parameters, the system goes to *Free* operation allowing each intersection to time independently on a semi-traffic actuated operation.

When the system was installed in 1964, Tenth Avenue South average daily traffic (ADT) was approximately 22,000 vehicles with the approach from the north on 9th Street having the highest side street volume of any intersection on the system. At that time, the approach volumes from the south at any signalized intersection were negligible. This provided little turning friction for the side street traffic entering Tenth Avenue South and permitted rather short and efficient side street timing, resulting in a greater amount of green time alloted to Tenth Avenue South.

The system that was set up in 1964 with 60-second, 70-second, and 80-second cycle lengths with a double alternate offset for average progression provided a satisfactory operation at that time.

The 1977 ADT on Tenth Avenue South was 30,000 vehicles. The peak hour approach volume from the north at 9th Street is currently the sixth highest approach volume instead of the highest. This indicates a rather drastic change in the complexion of traffic movements on the arterial. With

the increase of 36% of ADT and the extreme change in complexion of traffic generation onto and crossing Tenth Avenue South, the original settings are no longer efficient.

B. ANALYSIS OF EXISTING SYSTEM OPERATION

The TM-1 Master Controller has the capability of selecting three cycle lengths and three offsets per cycle based on sampled volumes of traffic. The three cycle lengths currently installed are 60, 70, and 80 seconds. During periods of light traffic volumes, a traffic adjusted system will operate in a *Free* mode allowing each intersection to time independently. During volume buildup and off peak daytime operation, the system would operate at the short cycle length. Any intermediate level of volume would call the second cycle length and the peak hours would call the longest cycle length into effect.

When the traffic volumes on Tenth Avenue South were at 22,000-23,000 ADT, the 60-second cycle would be in effect from approximately 6:30 a.m. until 11:30 a.m. at which time it would switch to the 70-second cycle. The 80-second cycle would only be in effect from about 4:30 p.m. until 6:00 p.m.

With the current traffic volumes of 30,000 ADT (a 36% increase) and the same cycle lengths in use, the system reaches the 80-second cycle by 7:30 a.m. and the cycle remains in effect until approximately 6:00 p.m.

Figure No. 14 is a time space diagram depicting the band widths of 35 MPH for each direction of travel on Tenth Avenue South. This is the 80-second cycle and average progression settings which currently operate throughout most of the day as mentioned above. The existing offsets are double alternate with a basic distance of 864 feet.

The City of Great Falls currently has a supply of 90-second gears available for the coordination units. Figure No. 15 is a time space diagram demonstrating improvement of progressive flow at 35 MPH by utilizing these gears and changing to a triple alternate offset. This improvement has been implemented with a noticeable improvement in traffic flow.

Figures No. 14 and 15 present the area of Tenth Avenue South from 2nd Street to 15th Street because of the greater density of signals. These diagrams can be applied throughout the entire system.

The electro-mechanical coordination equipment now in operation does not provide the accuracy or have the functional capability to efficiently control the traffic on this arterial. Also, being that it is electro-mechanical, it is subject to failure at a high rate.

The D2000 and D4000 controllers are very reliable solid state controllers, but do not possess a number of functions. The EMC4000 compatible controller may possibly be used in the new system. Extensive cabinet rewire would have to be done, however.

The T-517 controller has the capability of timing two phases with only one of the phases being actuated. To provide for separate left-turn movements, G2 Timers had to be included. The G2 Timer does not provide for a yellow clearance following the leading left-turn arrows. This is extremely unsafe and further does not comply with the Manual on Uniform Traffic Control Devices.

10th AVENUE SOUTH

THROUGH BAND COMPARISON

AT SPEED LIMIT (35 MPH)

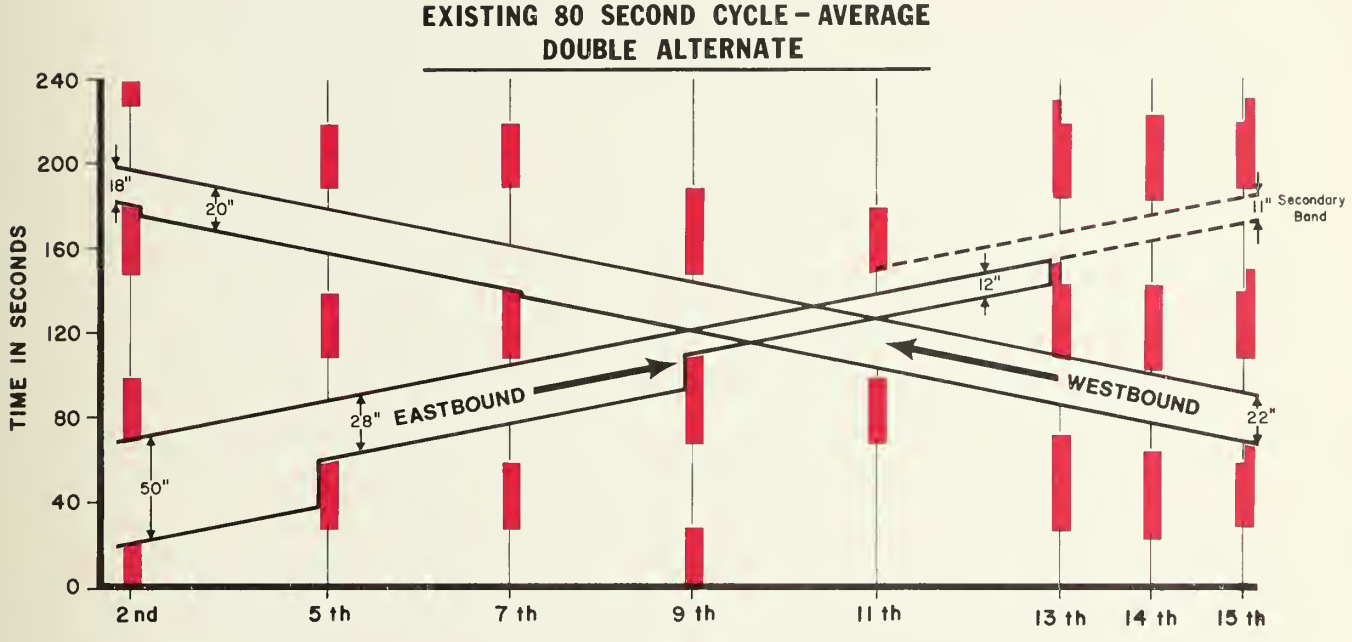


FIGURE 14

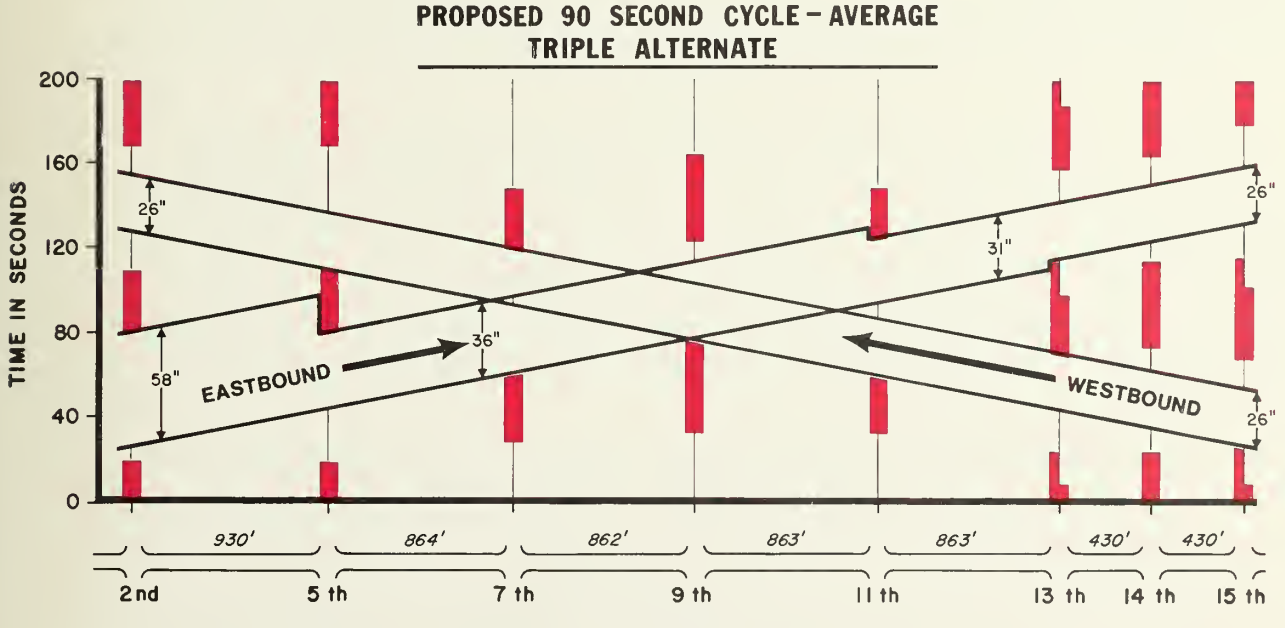


FIGURE 15

The control equipment at 2nd, 9th, 14th, and 15th should be replaced immediately from a liability standpoint without associating it with a possible new system project. New equipment installed at these locations on Tenth Avenue South would be useable at other locations should they not be totally compatible with a new system. The replacement equipment should be full traffic actuated.

C. PROPOSED SYSTEM DEVELOPMENT

The relative efficiency of a two-way progressive signal system is dependent on the distances between signalized intersections, the speed of traffic, roadway capacity, friction caused by turning vehicles, parking maneuvers, and pedestrians. In general, a two-way progression with maximum band widths can only be achieved if the signal spacings are such that vehicular travel times between signals are multiples of one-half the common cycle length.

To obtain maximum efficiency of a system, the goal is to select the shortest cycle length that will accommodate the traffic demands at a level of service desired. This will also keep the delay on the side streets to a minimum. A system established with maximum band widths will achieve this goal. Maximum band widths are obtained by a single alternate system. A double alternate system reduces through band widths to 50% of available arterial green time, and a triple alternate system reduces the band width to 33% of available arterial green time.

Figure No. 16 is a time space diagram developed using a basic signal spacing of 2,600 feet, speed of 35 MPH, and cycle length of 100 seconds. A split of 50% is shown for simplification. It has been established that this 100-second cycle will provide an efficient progression for traffic movement on Tenth Avenue South.

A basic signal spacing of 2,600 feet adopts very nicely to Tenth Avenue South block spacing. Signals placed at 2nd, 9th, 15th, 21st, 27th, etc. at 2,600-foot intervals provides optimum signal spacing,

Improperly located signals can severely affect traffic flow on an arterial. It is realized, however, that optimum spacing cannot always be adhered to, but must be attempted.

Distance from optimum location and the amount of total time the side street requires are interrelated. To minimize the effect of poor signal locations, it is necessary to decrease the amount of time available at key intersections to the cross street. Methods of decreasing required cross street timing are discussed in detail in the Tenth Avenue South Improvement Plan - Technical Supplement.

It is also demonstrated in this Supplement that a six-block spacing provides a wide range of cycle lengths for use. This will allow for the maximum flexibility in timing and coordination in the future.

D. INTERSECTION ANALYSIS

2nd Street at Warden Bridge

It must be realized that the Warden Bridge provides a constriction which severely restricts

10th AVENUE SOUTH

100 SECOND CYCLE – AVERAGE PROGRESSION

NOTES:

1. Progression speed is 35 m.p.h. for 100% of bandwidth except transition area.
2. Transition between 15th Street and 20th Street produces 29 m.p.h. for 100% of bandwidth.
3. Maximum allowable cross street time without reducing bandwidth is also shown for other than key locations.

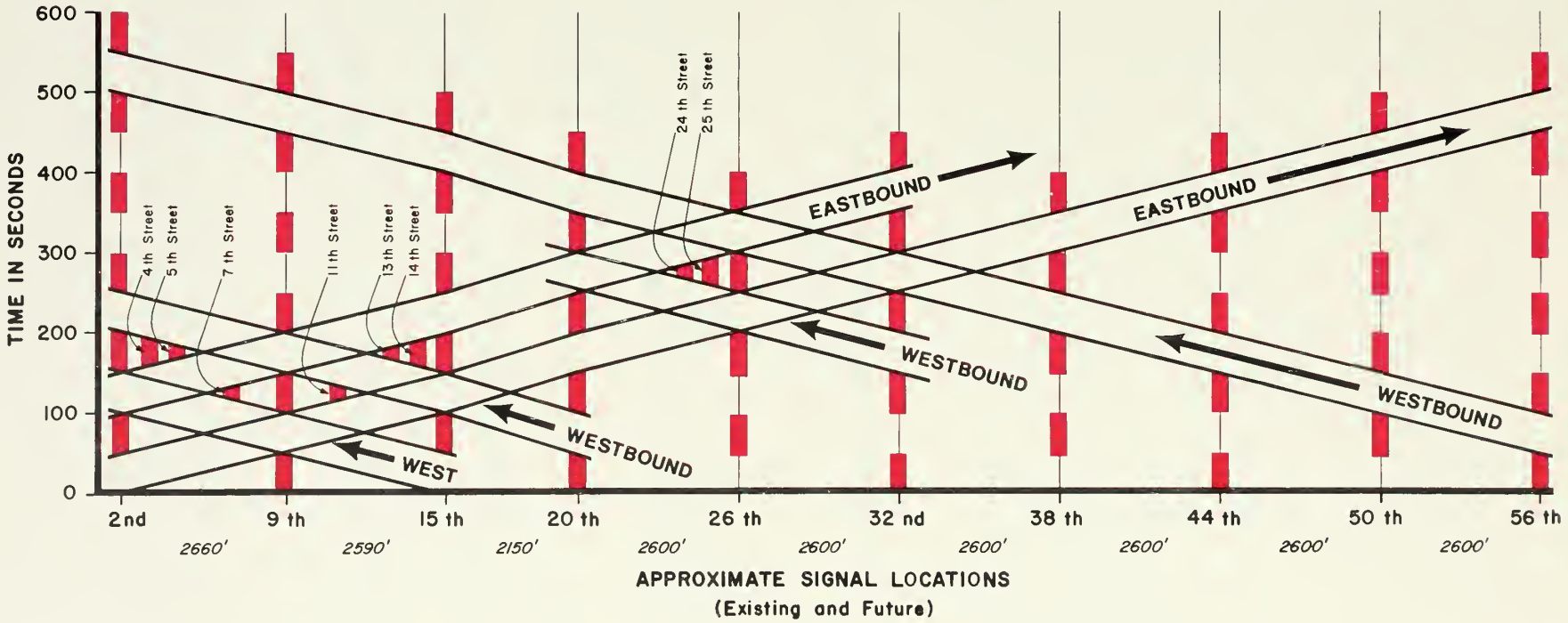


FIGURE 16

westbound traffic. Vehicles utilize the inside lane almost exclusively beginning at 7th Street. This reduces the capacity of the arterial and the situation cannot significantly be improved until the capacity of the bridge is increased.

The effect of opening the new 6th Street Southwest Bridge should reduce some of the demand across the Warden Bridge. Any other traffic engineering improvements that can be made on the route from the Fox Farm Road area to the City Center will tend to shunt traffic away from the Warden Bridge.

The ramp from 2nd Street joining Tenth Avenue South at the throat of the Warden Bridge results in an inadequate merge distance. This is a source of friction causing delays in the westbound traffic. Closing this ramp, causing the south to west traffic on 2nd Street to use the signalized intersection at 2nd Street, will provide a merge distance of greater than 750 feet. The greater merge distance will facilitate a more uniform speed and improve actual capacity at the bridge. It may also cause two additional secondary benefits, one being a queuing of eastbound traffic at the beginning of the signal system. The other benefit would be utilization of the outside lane westbound and the driver realization that they do not have to compete with vehicles merging at the bridge throat.

2nd Street

A dual ring controller capable of providing future left-turn phasing for all left turns should be installed at 2nd Street.

5th Street

Since 5th Street is two blocks from a key intersection and currently needs signalization due to being a portion of the couplet, the best that can be done here is to minimize the amount of green time it requires. This can be accomplished by:

(1) Attracting as many vehicles as possible to the key intersections of 2nd Street preferably, or to 9th Street.

(2) Continue 5th Street as one-way south of Tenth Avenue South thereby reducing friction from the opposite direction which will enable the southbound vehicles to clear faster. This will result in a larger green band on Tenth Avenue South.

(3) Provide a four-lane approach from the north. The lanes to be designated right only, right and through, left and through, and left only.

4th, 5th, and 6th Streets

With the increase of traffic generators south of the arterial in this area which will require access onto or across Tenth Avenue South, the following alternate is proposed which corresponds to the approach of keeping additional signals not at key locations as close as possible to the key intersections.

Move the existing 5th-6th Street one-way couplet one block to the west, making 4th Street

one-way southbound and 5th Street one-way northbound. This would eliminate the need to signalize 6th Street which would be absolutely disastrous to any progressive flow on the arterial.

The couplet should be designed to accommodate four lanes approaching the arterial to allow for dual left and right turns. This is necessary to keep side street time requirements to a minimum since this couplet is not at a key location. This is more essential at 5th Street than at 4th Street due to the lesser green time available for 5th Street.

Three phase controllers should be installed at 4th and 5th Streets.

7th Street

This signal should be removed.

9th Street

The key intersection of 9th Street requires a dual ring controller operating with eight phases. Widening of 9th Street to provide five lanes on both north and south approaches to Tenth Avenue South for an adequate distance to provide proper transition and usage should be accomplished.

11th Street

Eleventh Street signal should be removed.

13th, 14th, and 15th Streets

The signalization at 13th, 14th, and 15th Streets will continue to be the most restrictive area on the arterial. The greatest reason for this is the high side street demands at one and two blocks from the key intersection of 15th Street.

13th Street

The signal at 13th Street has a very high demand from the south as well as a high west to south left turn demand from the arterial. As in the case with 5th Street, everything possible to decrease the required timing to accommodate these vehicles should be accomplished. This would include the following recommendations:

(1) Continue the 14th and 15th Street couplet to 13th Avenue South and provide good access between the couplet and the shopping center along 11th and 12th Avenue South to attract as many vehicles as possible toward the key intersection location.

(2) 13th Street should be made one-way northbound from Tenth Avenue South to Ninth Avenue South to eliminate all conflicts for northbound and turning vehicles entering Tenth Avenue South and to permit double left turns.

(3) Provide a three-lane approach on 13th Street designated as left only, through and left only, and right only.

(4) The signal controller should be four phases. The right-turn lane from the south should have an overlap indication with the west to south left turn from the arterial.

(5) The left turn from the arterial should be a lagging movement for current operation, but should have capabilities of changing from lag to lead depending upon program in effect.

(6) The pedestrian movement across Tenth Avenue South should only be allowed on the west side of the intersection. To keep timing as efficiently as possible and to avoid conflicts with left turning traffic, it is necessary to have the pedestrian phase be separate. When a pedestrian call is answered, the west to south left turn shall be given a green light and the westbound overlap signal shall display a red. It shall be necessary to skip the controller phase timing of the left turn during that cycle.

14th Street

The signal at 14th Street should be three phases also with a west to south left-turn movement added to attract some of this demand away from 13th Street. The associated westbound through movement should be overlapped with the left turn. The left turn from the arterial should be a lagging movement currently.

15th Street

The east to north left turn from Tenth Avenue South is extremely heavy. A double left-turn movement should be established to efficiently accommodate the demand.

The approach from the south should be one-way as discussed earlier. Three lanes are required to allow the right-turn vehicles to separate from the heavy through movement which requires two lanes.

The controller phasing would be three phases.

20th Street

This signal location presents a problem for eastbound vehicles during winter driving conditions due to the 5.4% grade. For this reason, a west to south left turn should not be installed in the future.

15th Street to 20th Street is a transitional area from the original six block or approximate 2,600-foot spacing of key signal intersections. This appears to be necessary due to the great demand at 26th Street.

23rd Street

A signal at this location, however inviting, would prove to be disastrous to arterial flow. This applies to any intersection which is half-way between key signal locations.

25th and 26th Street One-Way System

When a one-way couplet would normally terminate at a major cross arterial, it is usually desirable to extend the couplet one block beyond the arterial. With the heavy generation from the Deaconess Hospital, this particularly applies.

To relieve the extreme demands from arterial green time at 26th, the following recommendations are made:

(1) Disperse the volume generated in the hospital area by:
   (a) Making 11th Avenue South a through street from 24th to 32nd Streets.
   (b) Obtain hospital staff cooperation in utilizing alternate routes.
   (c) Use trail blazer signs directing traffic to alternate routes.

(2) Provide four lanes for the approach from the south; left turn, through and left, through only, and right turn only.

(3) Provide double left-turn lanes for east to north left turn from the arterial.

(4) Install a two phase controller at 24th Street and provide double left-turn lanes for the north to west movement. (It is absolutely essential that the cross street green time be kept to a minimum as derived from time space diagrams.)

The controllers at 25th Street and 26th Street should be four phases in a dual ring configuration to obtain maximum efficiency. A lagging left turn would be utilized normally at 25th Street for west to south traffic. A lagging left turn would be utilized normally at 26th Street for east to north traffic.

29th Street

This intersection should not be signalized.

32nd Street

This street should be realigned to avoid conflicts of north and south left-turn movements which will permit more efficient timing when the volumes increase. Optimally, the street should be wide enough to accommodate three approach lanes and two lanes in the opposite direction. This intersection should be designed to attract extensive usage. The controller should be a full eight phases in a dual ring configuration.

38th Street

This street should also be realigned and improved as discussed at 32nd Street.

General

It is extremely desirable to have well-designed intersections at optimum locations for movement of arterial traffic. If this is accomplished prior to high cross street demand, the proper patterns and planning can be developed.

The remaining key intersections spaced at approximately 2,600 feet should become a portion of a master plan. Right-of-way of sufficient width to develop intersections as described for 32nd Street should be retained or acquired.

The key signal locations should be incorporated in the decision making process of major north-south through streets.

E. NEW TRAFFIC SYSTEMS - STATE OF THE ART

There has been an extensive amount of development work on computer systems in the past ten years. With the development of the minicomputer and the microprocessor in recent years, computerized traffic control has become an affordable reality.

Computerized traffic control systems consist of a number of elements. The very basic elements are: (1) Control Computer Hardware, (2) Computer Software, (3) Communications, (4) Local Controllers.

Computer Hardware

The central computer hardware requires a controlled environment location. This would be a reasonably dust-free area with air conditioning. A minimum of 100 square feet is generally required.

Computer Software

Computer software is very time consuming and costly to develop. Off-the-shelf programs are readily available, however. To assure a completely debugged program, one that has been in actual satisfactory use for a minimum of two years would provide reasonable assurance.

The computer package and communications should be designed for full feedback from each intersection to provide surveillance of both traffic and equipment.

Communications

To obtain the most flexibility and versatility of a system, it is essential that a great amount of information be transmitted to and from the intersections. This makes communications a very critical element. Speed of transmission, type of modulation, and error rate have to be considered.

For traffic control application, frequency shift keying (FKS) and phase shift keying (PSK) modulation at a rate less than 1800 band are the most satisfactory. FSK has the advantage of simpler hardware thereby making it less prone to failure. It has the following additional advantages when used at 1200 band rate:

(1) Circuits easily obtainable from Telephone Company.
(2) Easy to amplify.
(3) Very noise immune.
(4) Highly versatile with digital control.
(5) Not amplitude sensitive - requiring adjustment.

Local Controllers

Microprocessor based digital controllers are available and field proven for local control operations. Some of this type of equipment is designed to also be used in system operation with no specific additional programming necessary.

The microprocessor controller is extremely versatile and can provide such features as changing phase sequence from leading left-turn movements to lagging left-turn movements by command.

This particular feature would be extremely useful for intersections such as 15th and 26th Streets where very high left-turn demand exists at key locations, or at 13th Street where a medium demand exists and is not at a key location with regard to progression. These types of features provide the capability to optimize signal progression by innovative engineering.

The following elements are essential for a computerized system to control traffic effectively, especially in areas of severe congestion. They provide the features for on-line real time control.

System Sampling Detectors

These detectors will provide information for the computer to determine which program to select. These detectors must be located properly to provide timely information to the computer. It is essential that the computer program uses both volume and occupancy information from the samplers to select programs. If only volume is used, the system could break down under heavy traffic or improper progression which would give an indication of low volume when the exact opposite exists. If only occupancy information is used, light traffic moving at a good rate of speed does not give satisfactory information to select programs; therefore, the ability to use both volume and occupancy information is essential to good traffic control.

Display

With full feedback mentioned above, surveillance of both traffic and equipment is facilitated. An intersection layout can then be used to display all red-yellow-green, walk-don't walk lights as well as vehicle and pedestrian detection at any one intersection at a time.

Teletype/Printer

A teletype will provide a hard copy of any equipment failures and timing, program, or parameter changes. It can also provide copies of traffic counts when this is a part of the software program which is a very effective tool for system operation analysis.

Map Display

This would be very useful to the traffic engineer to provide a display of the entire system at one time for analytical purposes. It would also provide information at a glance if any intersection is dropped from computer control, thereby receiving immediate information that a local intersection is malfunctioning.

Portable CRT

Some computer systems have the ability to respond to a portable cathode ray tube with a keyboard. This can be a very useful maintenance tool. If the central computer is located remote from the maintenance personnel as is generally the case and a trouble call is reported, the computer can be called from any telephone and connected to the portable CRT. Any display information avail-

able at the master computer is then available on the portable CRT. Any function such as recalling a phase, changing time, or flashing an intersection for examples, can be done from any telephone.

Intersection Telephones

A telephone located in each controller cabinet to provide communication from the intersection to the master computer and between intersections is a very inexpensive maintenance tool.

Master systems are available which can control a number of zones simultaneously where zone is defined as an area with unique traffic patterns. Examples of zones in Great Falls would be the CBD, Tenth Avenue South, Central Avenue West, etc. A modular approach can be taken such as master control equipment necessary for Tenth Avenue South initially with approximately 15 intersections. Later, modules to provide for control of Central Avenue West can be added and controlled with the same master computer.

It is necessary that the computer software be able to control arterial traffic as well as CBD or grid operation traffic. This will provide a very versatile master for future development.

When bidding a computer system, it is very advisable to require total system responsibility. That is, one supplier is responsible for the central computer, communications equipment, local controllers and software operating as a complete system.

CHAPTER VIII

ACCESS PLAN

A. EXISTING DRIVEWAY ACCESSES

B. EVALUATION CRITERIA

C. ACCESS PLAN

CHAPTER VIII
ACCESS PLAN

A. EXISTING DRIVEWAY ACCESSES

Access to Tenth Avenue South is presently provided by at-grade street intersections and driveways. Consideration was given to the possibility of converting Tenth Avenue South to a limited access facility, but this consideration was discarded because (1) the function of providing access to adjacent business properties could not be provided with a limited access facility, (2) access rights to the street would have to be acquired, and it was felt that this action would be too expensive to be considered.

An inventory of the existing driveway accesses to Tenth Avenue South was made on October 19, 1970. This inventory revealed that there are 298 curb cuts and driveways from the Warden Bridge to 57th Street. The number of driveway accesses varies from one per block to seven per block.

It is evident from observations of traffic movement that this proliferation of driveway accesses causes erratic traffic movements and very likely increases the accident rates. This could not be proven directly by examining the 1976 and 1977 accident records, but it is noted that the accident rate is greatest where the number of driveway accesses is greatest. It was therefore surmised that if the number of driveway accesses could be reduced and their location controlled, drivers on Tenth Avenue South could anticipate where side street traffic would enter and be prepared for them. This would reduce the erratic traffic movements and, consequently, the number of accidents and the accident rate.

It is noted that Great Falls now uses the state accident reporting form which provides for recording driveway access accidents. This information will be valuable in the future for the evaluation of specific driveway accesses. This new form was adopted and in use in 1978.

B. EVALUATION CRITERIA

In the development of an access plan for Tenth Avenue South, specific criteria was established on which to base the evaluation. This criteria is as follows:

(1) If access to a business property could be provided from a side street instead of from Tenth Avenue South, this was considered the preferable method and driveway accesses to Tenth Avenue South were removed.

(2) If at all possible, driveway accesses closer than 50 feet from an intersection were removed.

(3) If access to all businesses could feasibly be provided by a combined traffic flow and parking scheme within a city block, this block was designated a commercial module. A commercial module is defined as a block where cooperative agreements for access and/or parking are required between property owners and was considered the first preference for access. Commercial modules would preferably have no mid-block access, and one mid-block access at the most.

(4) Where two businesses could be served by one driveway access located between the two adjacent businesses instead of separate accesses for each business, the driveway accesses were combined. It is emphasized that the development of this access plan was done by using this evaluation criteria and the judgement of the evaluator. In order to remove any particular driveway access and to reduce the total number of driveway accesses, each driveway will have to be evaluated individually and the property owner allowed the opportunity to offer his evaluation and comments. This would assure that any factors the evaluator may have overlooked and did not consider are taken into account in making the final decision on the driveway access.

(5) If a commercial module was not feasible due to the nature of the businesses or because it was not physically feasible, one mid-block access was considered as the next preference. If one mid-block access was not feasible, then the least number of driveway accesses that would provide reasonable access to every parcel was considered as the next choice.

C. ACCESS PLAN

By using this evaluation criteria and examining each block independently, the number of driveway accesses could be reduced from 298 to about 100 accesses and four commercial modules. The maximum number of accesses in any one block under this plan is three.

Of the approximately 200 driveway accesses that could be removed, about 35 of them could be removed in the near future without any noticeable adverse effect. For the remainder, some physical modifications would be required, and it is expected that the removal of these would be accomplished at the time major construction on the street is done. Recommended driveway access locations which constitute the access plan are shown in Figure No. 20, *Photographic Plan View of Recommended Improvement Plan.*

CHAPTER IX

GEOMETRIC DESIGN IMPROVEMENTS

A. ROADWAY SECTION IMPROVEMENTS

B. REALIGN 2ND STREET

C. REALIGN 32ND AND 10TH STREETS

CHAPTER IX
GEOMETRIC DESIGN IMPROVEMENTS

A. ROADWAY SECTION IMPROVEMENTS

The existing roadway section on Tenth Avenue South consists of a 16-foot median with left-turn bays, two 11-foot driving lanes, and a 10-foot emergency parking lane for a total roadway section width of 80 feet. Existing right-of-way varies from a minimum of 100 feet from Warden Bridge to 26th Street; from there, it widens steadily to 240 feet at Doris Drive and to 270 feet at 57th Street.

Tenth Avenue South operates very near its capacity limits for a good part of its length. Limiting driveway accesses and improving the traffic signal system as recommended previously in this report will improve the safety characteristics of the street and increase the capacity. However, increased traffic volumes projected in the Urban Transportation Plan would soon return the street to capacity operation regardless of the traffic signal system improvements made.

The most logical alternate to increase the capacity and to improve the traffic flow would be to increase the number of travel lanes from four to six. The proposed six-lane facility could operate with a left-turn bay in the median, two through lanes, and a right-hand lane that would accommodate slow moving traffic accessing to abutting business properties and act as an emergency pull-off lane. A facility of this type would fulfill the functions of Tenth Avenue South to act as both a through arterial and as a street providing access to businesses.

A six-lane facility could be constructed within the available right-of-way (see Figure No. 17, *Typical Cross-Sections for Geometric Improvements*). From Warden Bridge to 29th Street where 100 feet of right-of-way is available, the typical section would consist of a 16-foot median, two through lanes of 12 feet and 11 feet, a 13-foot right-hand lane, and a 6-foot back of curb sidewalk. The typical section from 29th Street to 32nd Street would include three lanes eastbound similar to the previous section, but only two 12-foot lanes and an 8-foot emergency parking lane westbound. The decision to use this section was based on the directional difference in volumes that occur and the capacity requirements of this area. From 32nd Street to 57th Street, the typical section would consist of a 16-foot median, two 12-foot through lanes, an 8-foot emergency parking lane, a landscaped boulevard of 8 feet, and a 5-foot sidewalk. From Doris Drive to 57th Street, the additional right-of-way on the north side of Tenth Avenue South could accommodate mini-parks and a bikeway.

Under the limitations of the available right-of-way, the dependency of existing businesses on the property access function of Tenth Avenue South, and additional capacity requirements due to existing and projected traffic volumes, this proposed six-lane street is the optimum facility considered feasible. The proposed facility is shown in Figure No. 20(A through Q), *Photographic Plan View of Recommended Improvement Plan.*

TYPICAL CROSS-SECTIONS

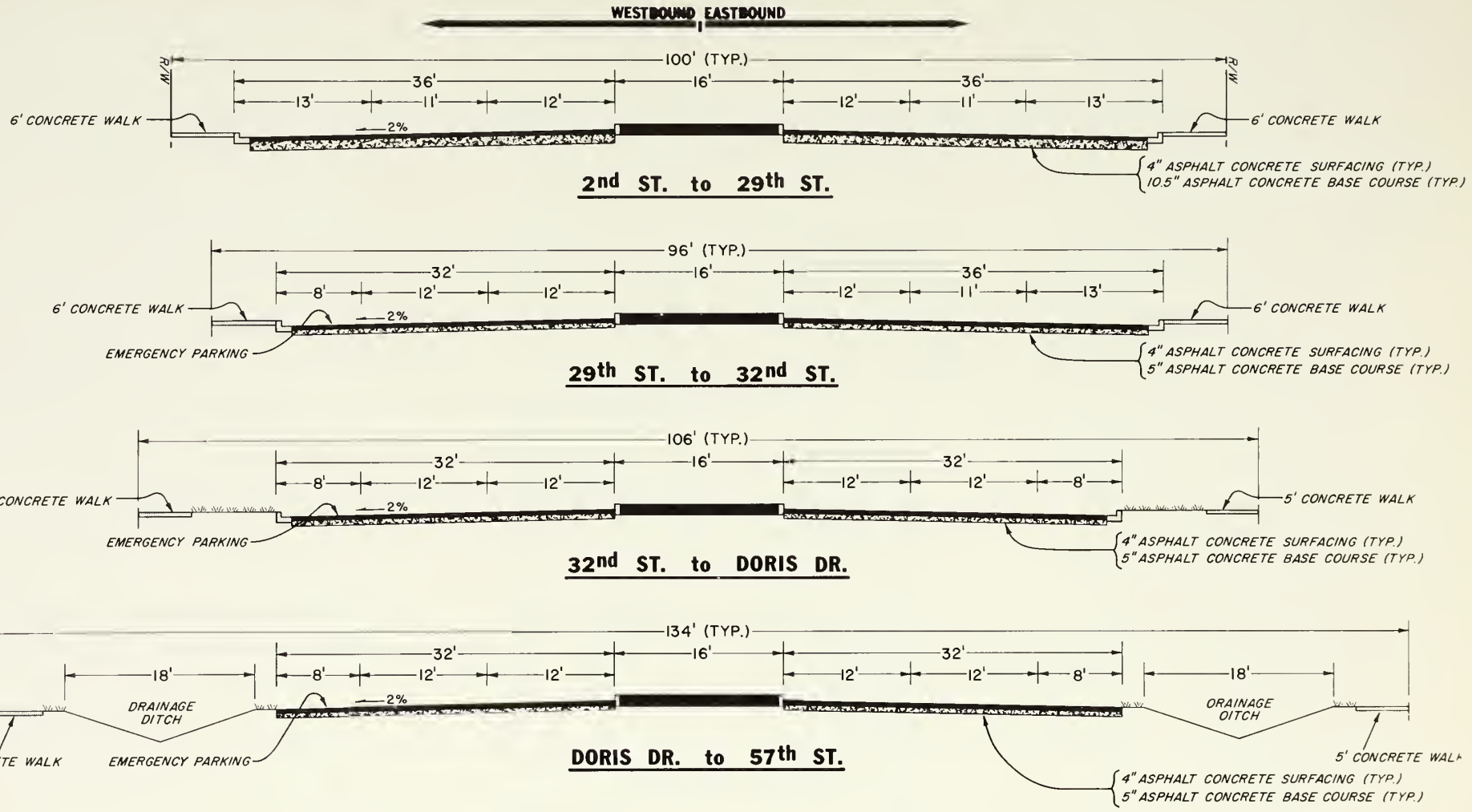


FIGURE 17

B. REALIGN 2ND STREET

The two-lane Warden Bridge is programmed for the construction of an additional two lanes in 1981. This should alleviate this serious constriction on Tenth Avenue South and will greatly improve traffic flow patterns. As a part of this improvement, the City of Great Falls has been working with the Montana Department of Highways to develop a proper connection of 2nd Street to Tenth Avenue South. Great Falls has identified 2nd Street as a vital transportation link to the downtown area and important to the success of the downtown redevelopment plan.

Several alternates have been proposed by the Montana Department of Highways and the City of Great Falls. The alternate that meets the functional needs of the intersection and the alternate most likely to be approved is shown in Figure No. 20A, *Photographic Plan View of Recommended Improvement Plan.*

C. REALIGN 32ND AND 10TH STREETS

The north and south approaches of 32nd Street onto Tenth Avenue South are offset by about 40 feet. An analysis of the accident records from 28th Street to 57th Street shows an average of five accidents per intersection, while 32nd Street has 28 accidents. This reflects the traffic conflicts arising from north and south left-turn movements and the desirability of realigning the intersection.

The recommended realignment and the proposed lane configuration is shown in plan view in Figure No. 20L.

The north and south approaches of 10th Street onto Tenth Avenue South are also offset by about 40 feet. Although this intersection does not show an unusually high number of accidents (probably due to low north and south approach volume traffic), realignment will provide a better intersection and improved access to the Holiday Village.

The recommended realignment and the proposed lane configuration is shown in plan view in Figure No. 20D.

CHAPTER X

STRIPING AND SIGNING IMPROVEMENTS

A. INTRODUCTION

B. EXISTING STRIPING PROCEDURES

C. RECOMMENDATIONS FOR STRIPING

D. SIGNING CONCEPTS

E. RECOMMENDATIONS FOR SIGNING IMPROVEMENTS

CHAPTER X
STRIPING AND SIGNING

A. INTRODUCTION

Traffic movement is greatly influenced by the availability or absence of traffic signs and striping on a roadway. Striping aids in channelizing traffic and informing the motorist of roadway restrictions on vehicle movements. Signing informs the motorist of traffic regulations, impending danger, or provides information to the motorist. Proper signing and striping that provides necessary information to the motorist aids in the efficient and safe movement of traffic.

B. EXISTING STRIPING PROCEDURES

Currently, striping on Tenth Avenue South is done by the Montana Department of Highways. Longitudinal lane lines are delineated by paint stripes. Crosswalks, turn arrows, and other instructions in the traffic lanes are thermoplastic lane markers. According to the Department of Highways, painting for lane striping is done every year. The plastic striping generally lasts for three years unless pavement failure shortens the life span. However, after three to four months of use, both the paint and thermoplastic stripes start to fade due to the high volume of traffic on Tenth Avenue South. Another problem noted with the striping is that the plastic is not skid resistant and in the case of wide-stop lane striping may constitute a traffic hazard.

C. RECOMMENDATIONS FOR STRIPING

There are some new products that may not have the disadvantages of the paint and plastic striping. In particular, a Canadian firm has marketed a new product that is a hot-melted thermoplastic extruded into a routed groove in the pavement. The product is self-cleaning, skid resistant, and long lasting. The Montana Department of Highways is conducting tests on this new product, and will soon be able to determine if the product is applicable to the road conditions in Montana and it is economically feasible to use.

Regardless of how good the striping is, it cannot last with the shifting and rolling that is occurring with the existing pavement. Until such time that the pavement section is stabilized, no product will last for any appreciable length of time.

If the new product proves to work out as well as claimed by the manufacturer, it is recommended that this type of striping be considered for striping across lanes under heavy traffic. The choice for longitudinal lane lines would be dependent upon the relative economics of a thermoplastic that lasts three years as compared to a paint that lasts one year.

D. SIGNING CONCEPTS

Traffic signs are used to convey information to the motorist where special regualtions apply or where hazards are self-evident. Normally, signs are not needed to confirm rules of the road. To be

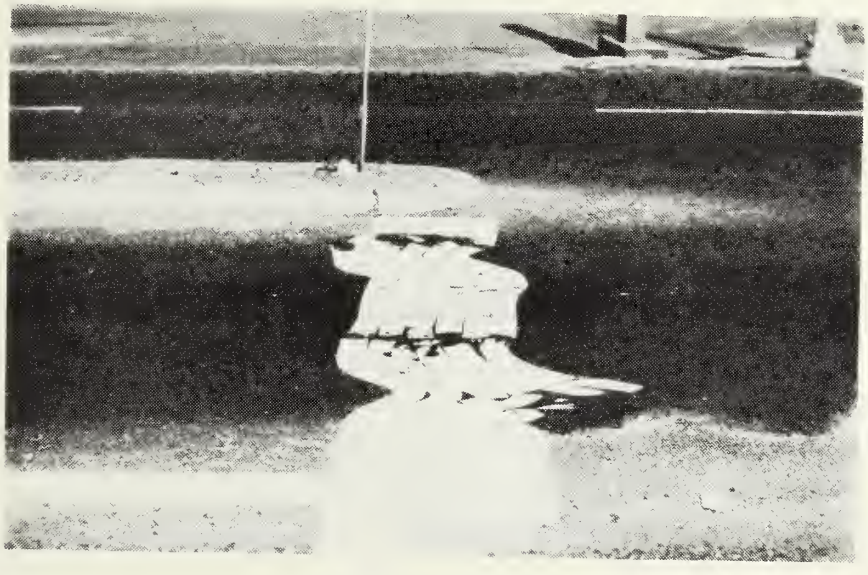
effective, signs should be readily discernable, easily understood, and provide adequate time for a proper response. It is particularly important that traffic signs (and other traffic control devices) are not overwhelmed by the presence of other competing commercial signs.

Signing problems noted on Tenth Avenue South included poor street name signs to aid the motorist to identify his location, inadequate one-way signs as indicated by the number of drivers turning the wrong way down a one-way street, and an inconsistency on the speed limit signs.

E. RECOMMENDATIONS FOR SIGNING IMPROVEMENTS

The City of Great Falls has prepared a uniform sign code that, among other purposes, is intended to restrict the placement of commercial signs that might confuse or obstruct the view or interpretation of official traffic signs or signals. The signing code provides for the removal of non-conforming signs based on a timetable contained in the code. It is recommended that a thorough sign inventory be done, and that those signs that interfere with the intent of traffic signs and are considered non-conforming by the signing code be removed according to the authority and timetable contained in the code.

Other sign recommendations include the installation of oversized street name signs placed at standardized locations, and improving the one-way signs. Some no-parking and other traffic signs should also be relocated and replaced in accordance with the City's signing inventory and analysis.



PHOTOGRAPH NO. 8
MOVEMENT AND SUBSEQUENT DETERIORATION OF STRIPING DUE TO PAVEMENT INSTABILITY AT 26TH STREET

CHAPTER XI

BEAUTIFICATION PLAN

A. BENEFITS OF BEAUTIFICATION

B. BEAUTIFICATION OPTIONS CONSIDERED

C. EVALUATION CRITERIA

D. COMMUNITY REVIEW

E. RECOMMENDATIONS FOR BEAUTIFICATION PLAN

CHAPTER XI
BEAUTIFICATION PLAN

A. BENEFITS OF BEAUTIFICATION

Special emphasis has been placed on beautification along Tenth Avenue South for a number of reasons. The primary reason is the dual function of Tenth Avenue South acting as an access to numerous businesses as well as being a through arterial street. A well-designed and landscaped street attracts customers and enhances business properties as well as breaking the monotony of the street and creating a more efficient travel facility. A good beautification plan will therefore be of benefit to the businesses on Tenth Avenue South, will provide for and encourage better traffic flow, and can be a source of pride for the community.

B. BEAUTIFICATION OPTIONS CONSIDERED

Along Tenth Avenue South, the opportunities for beautification vary considerably. From Warden Bridge to about 29th Street, the right-of-way is limited and will be entirely taken up by the proposed roadway section leaving only the medians and private property available for landscaping. From 29th Street to Doris Drive, the right-of-way widens to permit a planting strip between the curb and sidewalk as well as the medians and private property. From Doris Drive to 57th Street, the right-of-way is abundant and will permit mini-parks and a bikeway to be built on the north side of the street in addition to the other landscaping opportunities.

Several options were considered in the development of beautification concepts that could be applicable to Tenth Avenue South. These included painting of medians, colored and exposed aggregate, patterned or geometric finish on concrete, astro-turf, indoor-outdoor carpet, large embedded rocks and stumps, artificial shrubbery, and live shrubbery and grass. Of these options, painting of medians, astro-turf, indoor-outdoor carpet, and artificial shrubbery would not be compatible with the character of the street and should be discarded as options for beautification.

C. EVALUATION CRITERIA

The evaluation of the beautification options contained a number of considerations including the applicability of the option to the area proposed for beautification. Other criteria included safety considerations, aesthetics, durability, installation cost, and maintenance cost. On the basis of this criteria, it was established that a combination of methods for beautification depending on each circumstance would be applicable to the project. For medians that have a limited area and a hostile environment for live shrubbery, exposed aggregate, patterned or geometric finishes, and low-profile embedded physical features would be most applicable. Live shrubbery and grass are an option if it can be demonstrated that live plants would survive in the median. For planting strips between the curb and sidewalk, low-profile live shrubs and grass would be applicable. In the mini-parks area, large trees and shrubs with grass combined with pedestrian facilities such as park benches would be appropriate.

D. COMMUNITY REVIEW

To provide an indication of community acceptance, a presentation on the proposed beautification concepts was made to the Great Falls Community Beautification Association. A letter containing their comments is contained in the Tenth Avenue South Improvement Plan - Supplementary Report. The Community Beautification Association recommended that all medians over four feet wide should be landscaped with live vegetation with underground sprinkling and all boulevards and public lands along roadsides be landscaped. The comments contained in their letter as well as their verbal comments made during the presentation were taken into consideration in the development of the beautification plan.

E. RECOMMENDATIONS FOR BEAUTIFICATION PLAN

(1) At a minimum, medians should be landscaped at approximately one-half mile intervals as shown on the improvement plan to break up the monotony of the roadway. The type of landscaping applicable including the decision as to whether to use live plants with sprinkling systems or inanimate designs is a community decision.

(2) Boulevards between the curb and sidewalk should be made as wide as right-of-way will permit and should be landscaped with low-profile shrubs and grass.

(3) The wide right-of-way between Doris Drive and 57th Street should be used to develop mini-parks with a bikeway, walkway, pedestrian benches, and large trees and shrubs with grass.

LANDSCAPING CONCEPTS

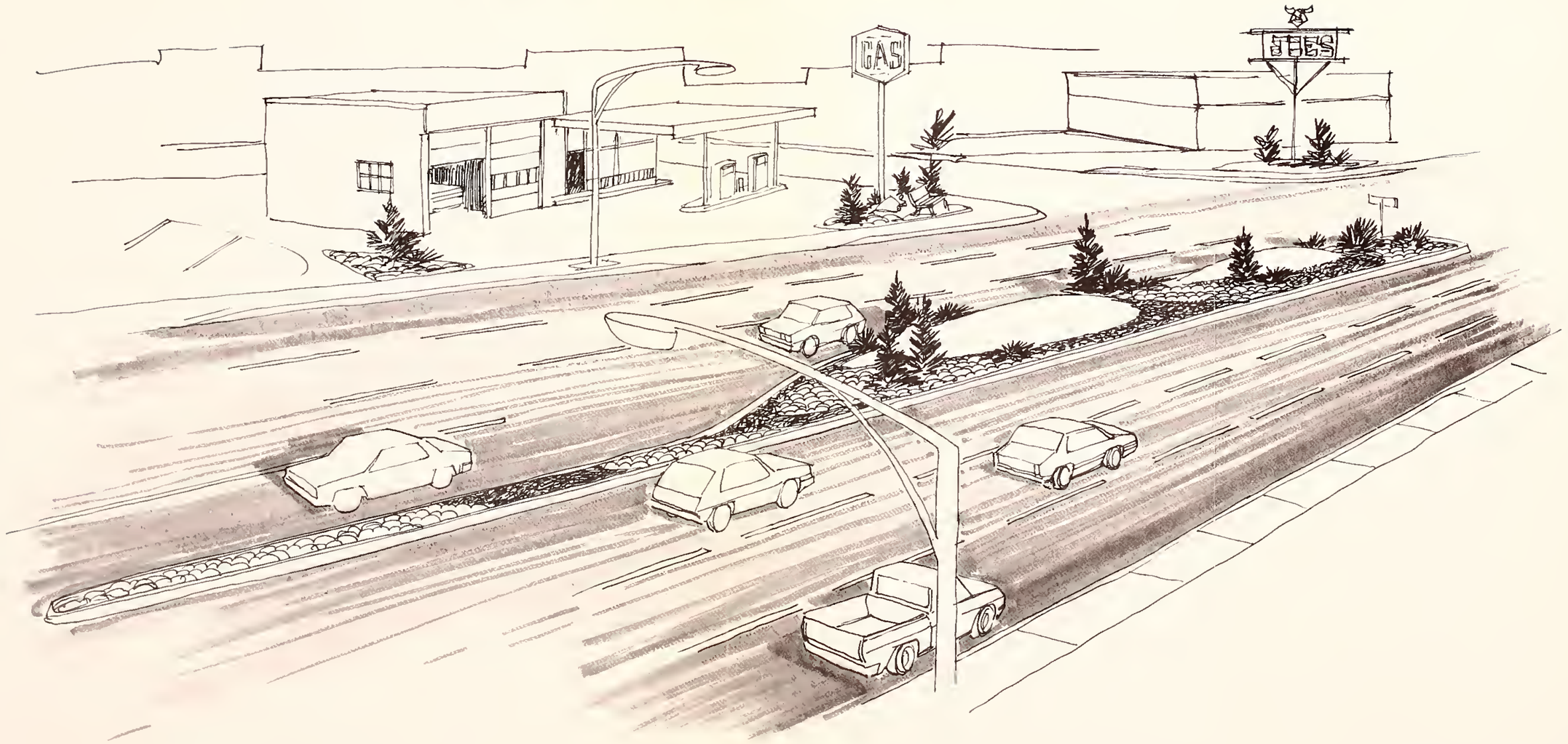


FIGURE 18

CHAPTER XII

CAPACITY ANALYSIS AND FUTURE REQUIREMENTS

A. CONCEPTS OF HIGHWAY CAPACITY

B. EXISTING TRAFFIC AND ROADWAY CONDITIONS

C. EXISTING CAPACITY

D. FUTURE TRAFFIC

E. FUTURE CAPACITY

F. SUMMARY AND CONCLUSIONS

CHAPTER XII
CAPACITY ANALYSIS AND FUTURE REQUIREMENTS

A. CONCEPTS OF HIGHWAY CAPACITY

This discussion of roadway capacity concerns itself with the maximum number of vehicles that have a reasonable expectation of passing over a section of roadway in a given period of time under prevailing roadway and traffic conditions. In this discussion, unless otherwise noted, *capacity* means the maximum capacity of the roadway.

It should be noted that there are some quirks in the highway capacity calculations, and that some specific operating characteristic may not be considered in a capacity calculation. It is stated in the *Traffic and Traffic Engineering Handbook* that the capacity analysis methods ... *are adequate for gross examination but seldom provide the knowledgeable user with a complete sense of ease when a precise answer is required.* In the case of the Tenth Avenue South project, some adjustments to the capacity calculations were necessary for the computations to conform to actual conditions. These adjustments are discussed later in this section.

B. EXISTING TRAFFIC AND ROADWAY CONDITIONS

Existing traffic on Tenth Avenue South was available from the Department of Highways permanent traffic counters located between 9th and 10th Streets, machine counts, and manual turning movement counts that were taken during peak traffic volumes. Information on the signal systems was available from the traffic signal system study discussed earlier in this report. Physical data was obtained from field measurements and aerial photographs. These studies provided the information needed to conduct the capacity calculations including approach width, percent of green time, directional factors, percent trucks, and turning movements.

C. EXISTING CAPACITY

The capacity of the existing roadway was computed on the basis of the existing operational and physical characteristics of the roadway. An operational characteristic of Tenth Avenue South whereby two 11-foot lanes are used for traffic and a 10-foot outside lane that is not used resulted in an excessively high capacity. The capacity calculations consider this width of approach as a three-lane approach and not as a two-lane as is the actual situation. To compensate for the limitations of the computations method, a 26-foot approach width was assumed, and calculations done on this basis. Figure No. 19 shows both the computations for the 32-foot section and the assumed 26-foot section.

From this figure, it can be noted that the roadway is nearing or has reached capacity at several intersections at present traffic volumes using the 26-foot section for capacity calculations. This corresponds to actual observations of traffic flow.

D. FUTURE TRAFFIC

The Great Falls City-County Planning Board in cooperation with the Montana Department of Highways conducted a 1978 update of the Great Falls Urban Transportation Plan. As part of the Transportation Plan Update, traffic assignments were done for the major street network, including future traffic assignments on Tenth Avenue South considering future traffic volumes both with and without the south arterial being constructed. These projected traffic volumes were used in evaluating the need for additional traffic lanes on Tenth Avenue South and for the evaluation of the south arterial.

E. FUTURE CAPACITY

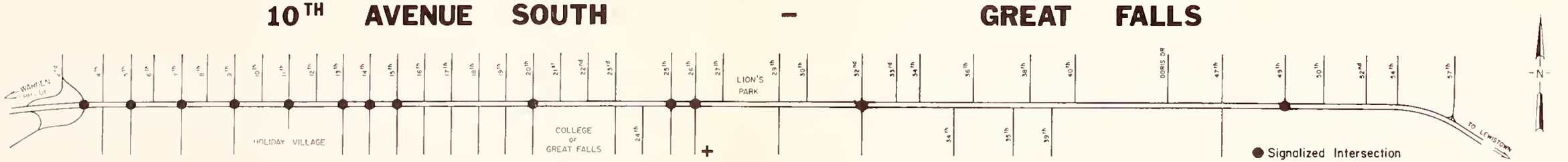
In order to meet the needs of the future traffic volumes, it will be necessary to add lanes to Tenth Avenue South. It would be possible to construct a six-lane facility within the available right-of-way and to substantially increase the capacity of the roadway. Traffic signal system modifications as proposed in Chapter VII - *Traffic Signal System* would also increase the capacity of the roadway. Figure No. 19 shows the effect that a six-lane facility and a modified traffic signal system will have on the capacity of Tenth Avenue South.

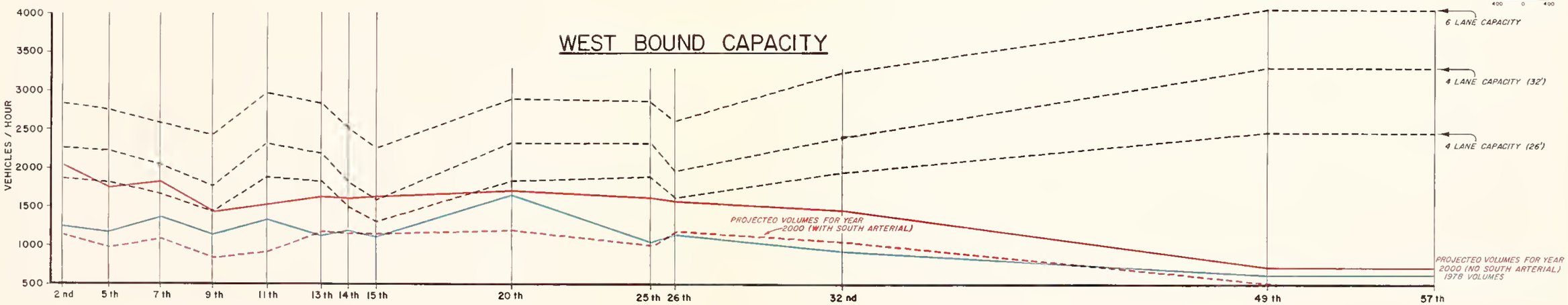
F. SUMMARY AND CONCLUSIONS

An inspection of Figure No. 19 reveals that Tenth Avenue South is near capacity in several areas at the present time, and that the facility will not be able to handle additional traffic without major modifications. The eastbound traffic is greater than the westbound on the figure, but this is a function of the directional factor in the afternoon when the peak period occurs. At other peak periods, the directional factor may change and the westbound traffic may be greater than the eastbound.

The figure also demonstrates that a six-lane facility from the Warden Bridge to 32nd Street and a four-lane facility from 32nd Street to 57th Street would accommodate projected traffic through the year 2000 even without the south arterial. If the south arterial is constructed, traffic volumes would drop to about the same level as 1978 traffic volumes, and the street would function at about the same level of efficiency that it does at the present time.

10TH AVENUE SOUTH - GREAT FALLS





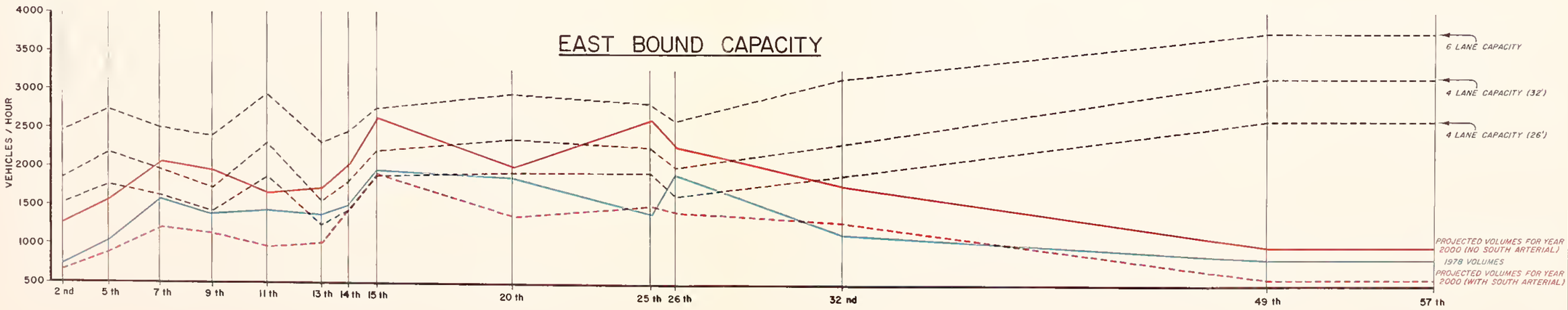


FIGURE 19

CHAPTER XIII

EVALUATION OF SOUTH ARTERIAL

A. EFFECT OF SOUTH ARTERIAL ON TENTH AVENUE SOUTH

B. TIME FRAME FOR CONSTRUCTION OF SOUTH ARTERIAL

C. SOUTH ARTERIAL COMPARED TO TENTH AVENUE SOUTH IMPROVEMENTS

CHAPTER XIII
EVALUATION OF SOUTH ARTERIAL

A. EFFECT OF SOUTH ARTERIAL ON TENTH AVENUE SOUTH

According to the traffic assignments prepared for the Great Falls Urban Transportation Plan Update, the south arterial would relieve traffic flow on Tenth Avenue South by 35% in the year 2000. On the basis of this information, traffic volumes on Tenth Avenue South in the year 2000 would be reduced to about the same level as they were in 1978. This information is depicted in Figure No. 19.

B. TIME FRAME FOR CONSTRUCTION OF SOUTH ARTERIAL

The diverting of traffic from Tenth Avenue South to the south arterial assumes that the entire length of the south arterial is constructed. The location study and environmental assessment for the south arterial is in process at the present time. Considering that right-of-way will have to be acquired, a major bridge over the Missouri River constructed, and eight miles of roadway constructed, it is doubtful that the entire length of the south arterial could be constructed before 1995 considering the complexity of the facility and the funding that would be required.

C. SOUTH ARTERIAL COMPARED TO TENTH AVENUE SOUTH IMPROVEMENTS

It was noted in Chapter VI - *Pavement Analysis and Improvements* that the pavement on a good portion of Tenth Avenue South is in very poor condition and will require replacement. The soils borings and pavement testing done by Northern Testing Laboratories indicates that reconstruction will be necessary to provide a structurally sound pavement. Since reconstruction will be required in any event, and only four feet of widening on each side of the roadway would be required to convert Tenth Avenue South to a six-lane facility, it would be reasonable to convert Tenth Avenue South to a six-lane facility at the time the pavement reconstruction is done.

In the event that the south arterial is not completed before 1995, traffic volumes will have nearly increased to the point that a six-lane facility would be needed on Tenth Avenue South even with the south arterial.

Construction priorities on these projects are of course a local prerogative. Considering the deteriorated state of the existing pavement and the near-capacity traffic flow on Tenth Avenue South, combined with the fact that a six-lane facility would be able to adequately handle traffic to the year 2000, it is our conclusion that improving Tenth Avenue South to a six-lane facility is of more immediate benefit than the south arterial. Of course, right-of-way acquisition and construction plans for the south arterial should proceed since it would be required after the year 2000 even if Tenth Avenue South is expanded to a six-lane facility.

CHAPTER XIV

RECOMMENDED IMPROVEMENT PLAN

A. INTRODUCTION

(1) Preliminary Design of Improvements

(2) New Street Lighting System

(3) Conduct Inventory and Improve Signs

(4) Replace Traffic Control Equipment at 3rd, 9th, 13th, and 15th Streets

(5) Realign 32nd and 10th Streets

(6) Remove Excess Driveway Accesses

(7) Move 5th and 6th Street One-Way Couplet to 4th and 5th Streets

(8) Continue One-Way Couplets to 11th Avenue South

(9) Improve Pedestrian and Bikeway Facilities

(10) Improve Storm Drainage

(11) Reconstruct Four Traffic Lanes and Medians From 2nd Street to 16th Street

(12) Reconstruct Four Traffic Lanes and Medians From 16th Street to 29th Street

(13) New Traffic Signal System - 2nd Street to 29th Street

(14) Widen to Six Lanes - 2nd Street to 16th Street

(15) Widen to Six Lanes - 16th Street to 29th Street

(16) Reconstruct to Five Lanes - 29th Street to 32nd Street

(17) Reconstruct Four Lanes - 32nd Street to 57th Street

(18) New Traffic Signal System - 29th to 57th Street

(19) Beautification

B. COST ESTIMATES

C. PROJECT BENEFITS

CHAPTER XIV
RECOMMENDED IMPROVEMENT PLAN

A. INTRODUCTION

It is obvious from the analyses that have been performed that the improvements proposed for Tenth Avenue South constitute a major program of expenditures. Even without widening the street to a six-lane arterial as recommended in this report, major improvements and substantial investments will be required. With this in mind, and recognizing that the improvements on Tenth Avenue South will have to compete with other proposed transportation improvements in Great Falls, the recommended improvement plan has been structured and sequenced to allow flexibility in the implementation of the proposed improvements.

To meet this objective, the proposed improvements have been sequenced into a logical order that would allow some improvements to be implemented in the near future even though funds are limited. Although the improvements are listed in the order that they are likely to occur, some adjustments in the sequencing may be desirable due to alternate funding sources, limitations, and availability. Descriptions of the proposed improvements are as follows:

(1) Preliminary Design of Improvements

Efficiency of investment and coordination of improvements in a stage construction program such as the improvement program planned for Tenth Avenue South can only be accomplished if a master plan to guide the improvements is prepared first. It is recommended that a preliminary design showing the existing facilities and proposed improvements be done as an initial step. This would provide a guide for the installation of improvements, and would assist in preventing improvements being made that would have to be removed or replaced for a later improvement.

(2) New Street Lighting System

It was demonstrated in Chapter IV - *Lighting System Analysis and Improvements* that the high pressure sodium vapor luminaries mounted on standards outside of the roadway provide much better lighting and result in a lower accident rate than the mercury vapor luminaries mounted on standards in the median. An added benefit is that the sodium vapor luminaries are much more energy efficient. It is recommended that the mercury vapor luminaries and median light standards from 2nd Street to 28th Street and from 34th Street to 38th Street be replaced with sodium vapor luminaries mounted on light standards outside of the median.

(3) Conduct Inventory and Improve Signs

Traffic and street name signs on Tenth Avenue South must compete with a proliferation of commercial signs for the motorists' attention. In some cases, traffic and street name signs

are not located properly, are difficult to see by the high speed and high volume traffic, or are missing. It is recommended that an inventory be done of the traffic and street name signs, and the areas where these signs are overshadowed by commercial signs. Existing street name signs should be replaced with larger street name signs placed at standard locations. Traffic signs should be relocated or replaced with more effective traffic signs and their conflict with commercial signs reduced by enforcing the City Signing Code, so that motorists will be better able to receive the information and instructions provided by the traffic signs.

(4) Replace Traffic Control Equipment at 3rd, 9th, 13th, and 15th Streets

The existing traffic control signals at the 3rd, 9th, 13th, and 15th Street locations do not provide for a yellow clearance following the leading left-turn arrows. This is unsafe and does not comply with the Manual on Uniform Traffic Control Devices. It is recommended that the control equipment at these locations be replaced as soon as possible to improve traffic flow and to avoid potential liability.

(5) Realign 32nd and 10th Streets

The north and south intersection approaches to Tenth Avenue South at 32nd Street are offset by approximately 40 feet. This offset causes erratic driver maneuvers and results in a higher accident rate at this intersection than at other intersections in this section of street. It is recommended that additional right-of-way be purchased and the intersection realigned to provide smoother traffic flow and a better configuration for making turning movements. The 10th Street intersection is also offset and should be realigned during reconstruction of Tenth Avenue South to avoid future problems that would arise if traffic on 10th Street were to increase.

(6) Remove Excess Driveway Accesses

During the inventory and analysis of driveway accesses to Tenth Avenue South, it was estimated that approximately 35 driveway accesses could be removed immediately with minor physical changes and without significant effect on business traffic patterns. It is recommended that a program of negotiation with the businesses and removal of these excess accesses be initiated.

(7) Move 5th and 6th Street One-Way Couplet to 4th and 5th Streets

The one-way couplet at 5th and 6th Streets will eventually require a signal at 6th Street as traffic increases. As discussed in the *Tenth Avenue South Improvement Plan - Technical Supplement*, a signal at 6th Street would be detrimental to traffic progression. Also, 6th Street ends at Tenth Avenue South and causes some confusion in traffic movement. It is recommended that the 5th and 6th Street couplet be adjusted one block west to a 4th and 5th Street couplet. This change will provide for better signal progression and will permit continuing the one-way couplet to 11th Avenue South, thereby eliminating some traffic confusion.

(8) Continue One-Way Couplets to 11th Avenue South

Changing traffic patterns inevitably causes some traffic confusion. At the present time, one-way couplets to Tenth Avenue South end at Tenth Avenue South. The heavy traffic volume on Tenth Avenue South adds to the confusion and puts the motorist in a stressful situation if he is not familiar with the required change in the traffic flow. It is recommended that the one-way couplets be terminated at 11th Avenue South where there is less traffic and the change in traffic flow patterns is less critical.

(9) Improve Pedestrian and Bikeway Facilities

Pedestrian facilities along Tenth Avenue South are in generally poor condition. Problems include lack of continuity or absence of sidewalks, non-functioning pedestrian heads on signals, poor crosswalk striping due to heavy traffic volumes, and blocking of pedestrian walkways. It is recommended that sidewalks be provided along the entire length of Tenth Avenue South, non-functioning pedestrian heads be replaced, new materials for crosswalk striping be considered, and pedestrian facilities be kept open for pedestrian use.

It is also recommended that a bike path be constructed in the road right-of-way from Doris Drive to 57th Street, and that 9th Avenue South be designated as a bike route from Doris Drive to 2nd Street. This route will provide continuity with the bikeway on the proposed new Warden Bridge.

(10) Improve Storm Drainage

Many of the problems with the pavement and ponding of storm waters on Tenth Avenue South can be attributed to inadequate storm drainage facilities. The removal of storm water from Tenth Avenue South has to be done in conjunction with the City Storm Drain Plan since the drainage from Tenth Avenue South drains into several separate storm drain sub-basins. It is recommended that grade modifications to the street profile and cross-section be done at the time of reconstruction, 34 new storm drain inlets be installed, and new storm drains be constructed in conformance with the City's Storm Drain Plan.

(11) Reconstruct Four Traffic Lanes and Medians From 2nd Street to 16th Street

The pavement section from 2nd Street to 16th Street is inadequate for the traffic volumes, the pavement condition is very poor, and this section breaks up badly in the spring due to a saturated subgrade. This pavement section is not considered salvageable. It is recommended that four traffic lanes and the medians be reconstructed from 2nd Street to 16th Street as the initial pavement improvement. By using proper stage construction methods, most traffic can be handled effectively during the construction period.

(12) Reconstruct Four Traffic Lanes and Medians From 16th Street to 29th Street

This pavement section is also considered inadequate at the present time according to the soils borings and pavement tests done, and it is recommended that this section of pavement be replaced as the second pavement reconstruction project.

(13) New Traffic Signal System - 2nd Street to 29th Street

The existing traffic signal control system on Tenth Avenue South is not flexible enough to adjust to changing traffic flow conditions. New computerized traffic control equipment now on the market can provide this versatility and flexibility, and improve the flow of traffic. It is recommended that a new traffic signal system utilizing a central computer control be considered for Tenth Avenue South. By modular expansion, this system could eventually control the traffic signal systems throughout the city.

(14) Widen to Six Lanes - 2nd Street to 16th Street

With the construction of the inside four lanes, traffic will be able to move freely on Tenth Avenue South while construction is being done on the outside lanes. Expanding the street from a four-lane facility to a six-lane facility will require widening the existing roadway section by four feet and replacing the curb, gutter and sidewalk. It is recommended that Tenth Avenue South be widened to a six-lane facility as funds permit with the 2nd Street to 16th Street section being designated as the highest priority.

(15) Widen to Six Lanes - 16th Street to 29th Street

This section of roadway is recommended as the second priority in widening Tenth Avenue South to a six-lane facility.

(16) Reconstruct to Five Lanes - 29th Street to 32nd Street

This section of roadway has a present remaining pavement service life of about five to ten years, but has localized incidences of pavement failure. This section of roadway will also require widening to provide adequate capacity. It is recommended that this section of roadway be widened to three lanes eastbound and two lanes westbound from 29th Street to 32nd Street.

(17) Reconstruct Four Lanes - 32nd Street to 57th Street

According to the capacity calculations, a four-lane facility will handle the traffic volumes to the year 2000. However, the existing pavement only has a remaining life of from about five to ten years. It is recommended that this section be reconstructed as a four-lane facility unless the anticipated traffic volumes at the time this improvement is programmed justifies the need for a six-lane facility.

(18) New Traffic Signal System - 29th to 57th Street

Traffic signals from 29th Street to 57th Street should be coordinated with the new generation traffic signal system as prescribed in Improvement No. 13 to provide consistent traffic control throughout the length of Tenth Avenue South.

(19) Beautification

Beautification elements of the proposed improvements are of concern to Great Falls as indicated by the interest of the Great Falls Community Beautification Association in this project. Areas of potential beautification include the right-of-way available at the east end of the Warden Bridge, landscaping treatment in the medians, boulevards between the back-of-curb and sidewalk from 29th Street to 57th Street, and the large amount of right-of-way from Doris Drive to 57th Street that could be developed into mini-parks. These beautification options have been included as part of this improvement plan.

In addition to the improvements for Tenth Avenue South, it would be beneficial if all parking lots and driveways along Tenth Avenue South were paved. This would reduce air quality problems and improve the appearance of adjacent properties. It is recommended that the City encourage these types of improvements on private properties where practical.

B. COST ESTIMATES

An estimate of the cost was made for each improvement plan project. Quantity take-offs for each project were done for the major construction items, and appropriate unit bid prices applied to these quantities to arrive at an estimated construction cost. Miscellaneous bid items that may not have been included in the quantity take-offs were accounted for by adding 10% of the major construction items to cover miscellaneous bid items.

Recognizing that construction activities on a heavily traveled street such as Tenth Avenue South will be more expensive than a normal construction project, a 10% traffic control item was included as a separate cost. Administration, engineering, and contingencies were estimated to be about 25% of the construction cost, and were included in the cost estimates as a separate cost. The combination of the above cost estimate categories gives the total project cost.

Table No. 4 which follows shows the cost estimates for the proposed improvement plan.

Table No. 4

COST ESTIMATE

Project	Construct. Cost	Traffic Control (10%)	Admin. Engin. & Contingen. (25%)	Total Project Cost	Time Improve-ment Is Needed
(1) Preliminary Design of Improvements .				$ 140,000	Now
(2) New Street Lighting System .....$	592,201	$ 59,220	$148,050	799,471	Now
(3) Conduct Inventory and Improve Signs	17,875	1,788	4,469	24,132	Now
(4) Replace Traffic Control Equipment at 3rd, 9th, 13th and 15th Streets.	99,000	9,900	24,750	133,650	Now
(5) Realign 32nd and 10th Streets	108,239	10,824	27,060	146,123	Now
(6) Remove Excess Driveway Accesses ..	51,700	5,170	12,925	69,795	Now
(7) Move 5th and 6th Street One-Way Couplet to 4th and 5th Streets ...	89,859	8,986	22,465	121,310	Now
(8) Continue One-Way Couplets to 11th Avenue South	14,784	1,478	3,696	19,958	Now
(9) Improve Pedestrian and Bikeway Facilities	59,403	5,940	14,851	80,194	Now
(10) Improve Storm Drainage	468,369	46,837	117,092	632,298	Now
(11) Reconstruct Four Traffic Lanes and Medians - 2nd St. to 16th St	1,074,941	107,494	268,735	1,451,170	Now
(12) Reconstruct Four Traffic Lanes and Medians - 16th St. to 29th St.....	466,916	46,692	116,729	630,337	Now
(13) New Traffic Signal System - 2nd Street to 29th Street	243,100	24,310	60,775	328,185	Now
(14) Widen to Six Lanes - 2nd Street to 16th Street	620,978	62,098	155,245	838,321	Now
(15) Widen to Six Lanes - 16th Street to 29th Street	425,681	42,568	106,420	574,669	Now
(16) Reconstruct to Five Lanes - 29th Street to 32nd Street	319,051	31,905	79,763	430,719	1980-1985
(17) Reconstruct Four Lanes - 32nd Street to 57th Street	792,816	79,282	198,204	1,070,302	1985-1990
(18) New Traffic Signal System - 29th Street to 57th Street.....	254,000	25,400	63,500	342,900	1985-1990
(19) Beautification	588,500	58,850	147,125	794,475	With const. projects
TOTAL PROJECT COST				$8,628,009	

C. PROJECT BENEFITS

This improvement plan includes a number of project types with varying benefits. Because of this variety of project types, benefits range from accident reductions to reducing vehicular maintenance. It would be difficult to accurately estimate the cost savings for some of these benefits, and in many cases, guesses would have to be made. The comparison of the benefit/cost ratios of projects where the benefits are well defined to projects where the benefits are less well defined may be more misleading than the value of establishing a benefit/cost ratio for each project. To avoid a possible misrepresentation of each project's importance, it was decided to list the benefits of each project without applying a dollar amount to the benefits. Each improvement plan project can then be assigned a priority rating by the Great Falls Technical Advisory Committee and can be included in the Transportation Improvement Program.

The improvement plan projects and a listing of the anticipated benefits for each are as follows:

IMPROVEMENT PLAN BENEFITS

(1) Preliminary Design of Improvements

(a) An overall plan would reduce conflicts between various projects.

(b) Projects could be done as soon as funds are available without the usual planning and engineering lag time.

(c) Improvements could be staged according to funding limitations.

(d) Some projects could be done simultaneously.

(e) Base information would be applicable to virtually all projects.

(2) New Street Lighting System

(a) Better driving conditions.

(b) Reduced accident rates (20%).

(c) Reduced crime rates (30 to 40%).

(d) 50% more energy efficient.

(e) Lower maintenance costs.

(f) Higher sales for businesses.

(3) Conduct Inventory and Improve Signs

(a) Reduce confusion by standardizing street signing system resulting in fewer accidents and less delay.

(b) More efficient traffic system and better speed control.

(c) Alleviate confusion at one-way couplets by better information transfer to drivers.

(d) Fewer traffic infractions due to clearer messages.

(4) Replace Traffic Control Equipment at 3rd, 9th, 13th, and 15th Streets

(a) Reduce possibility of a lawsuit due to non-conformance with Manual on Uniform Traffic Control Devices.

(b) Improved traffic flow and traffic control at intersections involved, thereby reducing accidents at these locations.

(5) Realign 32nd and 10th Streets

(a) Improve quality of travel on 32nd Street and 10th Street.

(b) Major reduction of accidents at these locations (75%).

(c) Reduce turning movement conflicts.

(6) Remove Excess Driveway Accesses

(a) Reduce random entry onto Tenth Avenue South.

(b) Channelize vehicles so that drivers on Tenth Avenue South can anticipate where access traffic will occur.

(c) Reduce erratic maneuvers to avoid unexpected access vehicles and thereby reduce accidents and delay.

(d) Improve off-street circulation patterns.

(7) Move 5th and 6th Street One-Way Couplet to 4th and 5th Streets

(a) Better signal spacing and increased cross-street green time.

(b) Improve traffic flow traveling north-south through better alignment and continuation of one-way couplet to 11th Avenue South.

(c) Improve access to Tenth Avenue South for the development to the south.

(8) Continue One-Way Couplets to 11th Avenue South

(a) Reduction of congestion and delays caused by terminating one-way couplet at Tenth Avenue South.

(b) Reduction of accidents at these major intersections.

(9) Improve Pedestrian and Bikeway Facilities

(a) Increased pedestrian and biker traffic which will slightly reduce vehicular traffic and save resources.

(b) Reduce number of bikers on Tenth Avenue South by directing them to 9th Avenue South, thereby improving safety characteristics of Tenth Avenue South.

(c) Better pedestrian facilities will reduce jaywalkers.

(10) Improve Storm Drainage

(a) Removing surface water will improve driving conditions.

(b) Hydroplaning by vehicles will be reduced.

(c) Pavement will last longer, breakup will be reduced, and maintenance costs will be less.

(d) Accidents and delay will be reduced due to better roadway conditions.

(11) Reconstruct Four Traffic Lanes and Medians From 2nd Street to 16th Street

(a) The soft grooved pavement susceptible to spring breakup will be replaced with a smooth riding surface.

(b) Roadway maintenance costs will be lowered.

(c) Vehicle damage due to the rough road will be reduced.

(d) Accidents caused by the irregular surface will be reduced.

(e) Traffic interference caused by periodic pavement repair will be reduced.

(f) Vehicles will be able to maintain a more constant traffic flow pattern which will increase capacity.

(12) Reconstruct Four Traffic Lanes and Medians From 16th Street to 29th Street

(a) Benefits are the same as Improvement No. 11.

(13) New Traffic Signal System - 2nd Street to 29th Street

(a) More efficient traffic movement which will increase overall travel speeds and reduce delay and congestion.

(b) Increase in roadway capacity due to better traffic flow patterns.

(c) More flexibility in the traffic signal system which will be able to adjust to widely varying traffic volumes.

(d) More reliability and less down time with reduced maintenance costs.

(e) A probable reduction in accidents.

(14) Widen to Six Lanes - 2nd Street to 16th Street

(a) Increase capacity to meet projected traffic volumes.

(b) Improve access to adjacent properties by providing a slow moving traffic lane.

(c) Improve travel speeds and reduce delays by providing two through lanes of traffic.

(d) Reduce accidents by removing from the through lanes of traffic vehicles desiring to access adjacent properties.

(15) Widen to Six Lanes - 16th Street to 29th Street

(a) Benefits are the same as Improvement No. 14.

(16) Reconstruct to Five Lanes - 29th Street to 32nd Street

(a) Benefits are the same as Improvement No. 14.

(17) Reconstruct Four Lanes - 32nd Street to 57th Street

(a) Benefits are the same as Improvement No. 11.

(18) New Traffic Signal System - 29th to 57th Street

(a) Benefits are the same as Improvement No. 13.

(19) Beautification

(a) Improve visual effect of street and create a better human environment.

(b) Aid in channelization of traffic.

CHAPTER XV

REVIEW AND COMMENTS

CHAPTER XV
REVIEW AND COMMENTS

This project was subject to review and comment at several stages of development. Technical review was provided by the Great Falls Technical Advisory Committee. Review on the beautification plan was provided by the Great Falls Community Beautification Association. Review on the access plan was done at a meeting with the Great Falls Chamber of Commerce, and by having the proposed access plan available for inspection by merchants along Tenth Avenue South.

In addition to these special reviews, media coverage included a number of newspaper articles and television news clips about the project, and a one-half hour television interview on the project. The Technical Advisory Committee meetings were open to the public, and several were well attended by people interested in the Tenth Avenue South project.

At the conclusion of the preparation of the draft report, written comments were solicited. Technical comments provided by the Great Falls City-County Planning Board, the Montana Department of Highways, and the Federal Highway Administration have been incorporated into the final text where applicable. A summary of comments from the public is contained below.

SUMMARY OF PUBLIC COMMENTS

Comment From:	Summary of Comment
L. D. McGlynn, M.D.	Suggests that a solid divider be placed along the entire length of Tenth Avenue South so that traffic cannot cross except at intersections with stop lights.
Otto Shine Car Wash	Opposes the conversion of Tenth Avenue South to a six-lane highway and the elimination of one of their two curb cuts.
Frontier Dodge, Inc.	Opposes the conversion of Tenth Avenue South to a six-lane highway and the elimination of any of their six curb cuts.
NOVCO	The one curb cut between NOVCO and Fuller Paint Company is necessary and removing it would be a hardship.
Holiday Car Wash	Removal of the corner curb cut would create a hardship and would create a dangerous traffic situation.
Virginia B. Hallock	Recommends leaving Tenth Avenue South as is and construct the south arterial for through traffic.
Midas Muffler	The curb cut should remain on the southeast sector of the lot since moving it will cause problems with existing parking.
Sleep Center	The curb cut taken between 29th and 30th is in the wrong place on the south side of the street.
Safeway	The curb cut proposal is inadequate for access to Safeway's parking lot, and will hamper business volume.

Comment From:	Summary of Comment
Taco John's	Doesn't think that the curb cuts should be taken out since business needs easy access.
Burger King	Asks if the access between Husky and Burger King is for both businesses or is one access to Burger King going to be taken? (The plan shows one access for Burger King plus another shared access with Husky.)
Creative Plastercrafts	Doesn't see how one ramp between Creative Plastercrafts and Pizza Hut would serve since half the time you can't get between the two buildings. The curb cut between the two buildings should be eliminated instead of the other two curb cuts.
Midway Toyota	Feels that Midway Toyota has a legal right to their curb opening since they have a driveway access permit, and that they were never notified of any meeting on the project and should have been.
Pardis Chiropractic Clinic	Protests removing his curb cut and having to share a curb cut with Wendy's Hamburgers. Suggests making the outside lane on Tenth Avenue South right turns only for better ingress and egress to property.
Blue Cross	States that it is not practical to reduce curb cuts into Blue Cross property from three to one because there are five separate businesses operating from their property, and that the side street access to 36th Street as proposed would create a serious traffic hazard.
Ski's Western Motel	Protests the elimination of curb cuts on Tenth Avenue South, and that a great inconvenience would be created toward potential customers resulting in a financial loss.
Coast-to-Coast Stores	Objects to eliminating curb cuts in front of Coast-to-Coast Store, and that ease of access and convenient parking are essential to a good hardware store. (Three letters received.)
McCollum Modern RV's	The curb cut on the east end of the property is utilized for exit only which is shown on the plan as being eliminated. Believes analysis of the situation should show the safety factor is superior as currently being utilized.
Bison Motor Company	Customers have access to Bison Motors facilities from four curb cuts in over 800 feet of frontal area on Tenth Avenue South. The company has the minimum number of curb cuts it can exist with, and to reduce the current number would severely limit ability to serve customers.

Comment From:	Summary of Comment
Eastside Bank	The proposal indicates eliminating all three curb cuts between 22nd and 23rd Streets. Eastside Bank would like consideration to retain one curb cut since it is essential to have one access directly from Tenth Avenue South into the West Parking Lot.
B. B. Briscoe	New street lights should be installed from Warden Bridge to 38th Street and from 28th to 34th Streets with the expense of removal and reinstallation borne by the SID. The open ditch drainage as shown on Figure 17 is ludicrous. Drainage grades can be corrected by gutter line adjustments. Relocating 5th and 6th Street couplet to 4th and 5th Streets will result in major disturbances to existing traffic patterns and is not justified to accommodate access to Tenth Avenue South. The conditions on Tenth Avenue South make it mandatory to provide for Portland Cement concrete surfacing. Mr. Briscoe's attitude toward the report and its recommendations is that it was not worth the cost of the study.
Gordon's Restaurant	The proposed change in curb cuts would affect their entrances and create a bottleneck on 7th Street.
Holiday Car Wash	If safety was the prime purpose of the study, the proposed curb cuts would not be located in blind alley exit situations. Personal observations indicated that congested curb cuts lead to driving over sidewalks and curbs at any place convenient. Doesn't think that human nature was a factor in the study.
Clifford D. Cory	The one curb cut planned for the Conoco Station and none for his parking lot would create an impossible situation since he has no legal right to drive through the service station to get to his parking lot.
Noble's Conoco	The proposed removal of curb cuts would be a detriment to their business, and it would be impossible for the large tanker trucks which serve the business to get in and out.
Beautification Association	The Great Falls Community Beautification Association submitted a petition stating that: *We, the undersigned, consider the landscaping and beautification of the median on 10th Avenue South, at 25th Street, in the City of Great Falls, by the Community Beautification Association of Great Falls, to be a significant and highly commendable endeavor to beautify 10th Avenue South, and we endorse and recommend further and additional landscaping and beautification efforts along the entirety of 10th Avenue South by the State of Montana and the City of Great Falls.* This petition was signed by 287 persons.

Comment From:	Summary of Comment
Chamber of Commerce	The Great Falls Chamber of Commerce concurs with the report's recommendations with the following exceptions: (1) the ramifications of the recommendation to move the 5th and 6th Street one-way couplet to 4th and 5th Streets need to be re-examined, (2) there is strong local sentiment that more median beautification than is recommended by the consultant should be installed, (3) individual attention must be given to the closure of any curb cuts.

A majority of the comments made are concerned about curb cuts to specific properties. Resolving these problems will have to be done through a negotiation process, and it is not considered practical to attempt to resolve the details of each curb cut at this stage.

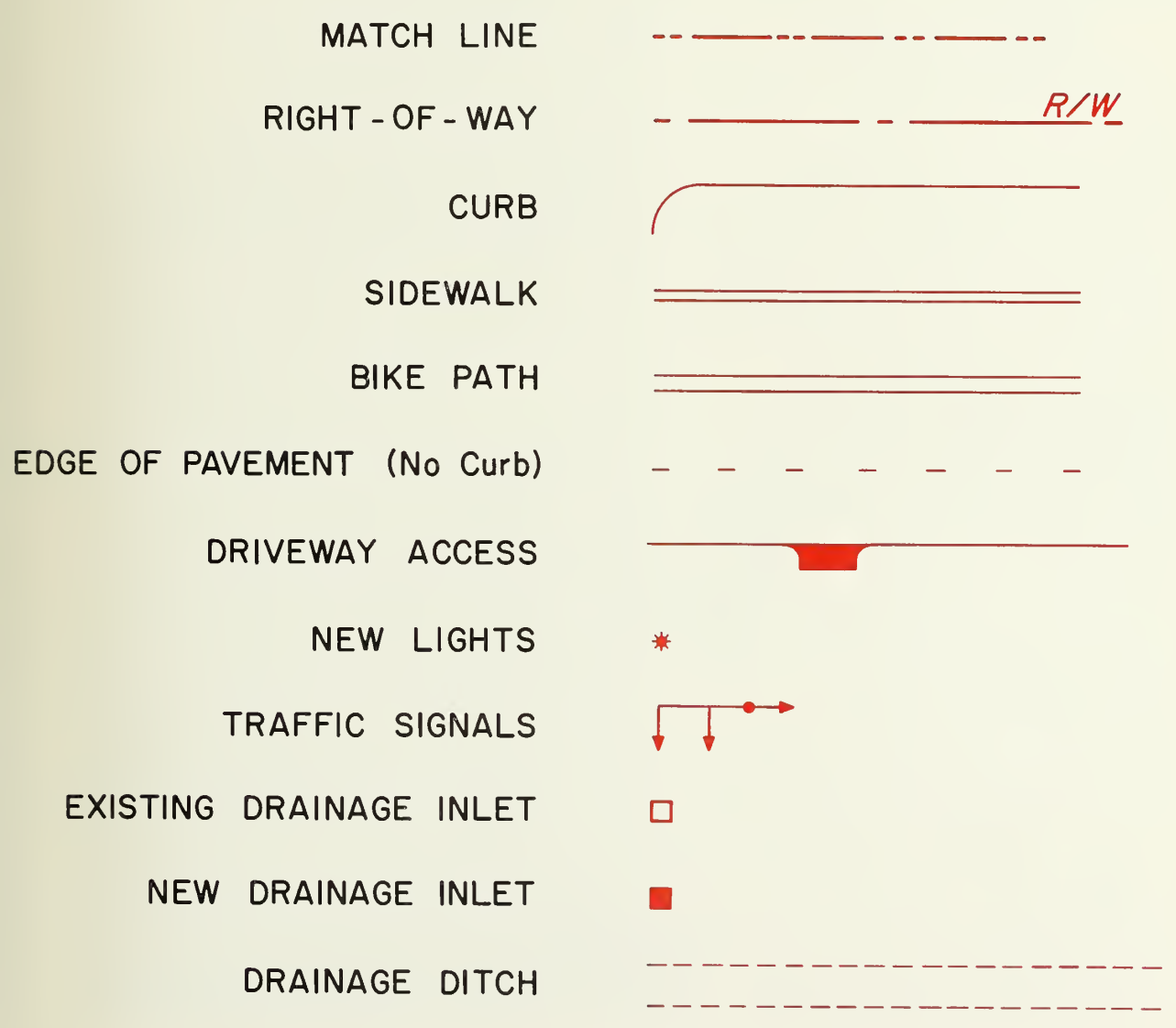
A number of comments were also received voicing concern over moving the 5th and 6th Street one-way couplet to 4th and 5th Streets. It is recognized that disruption of existing traffic patterns and possible land use conflicts may result, but leaving the 5th and 6th Street couplet implies that a signal would eventually be placed at 6th Street on Tenth Avenue South. This would be disastrous to traffic progression on Tenth Avenue South. Resolving this conflict will require the local authorities to carefully weigh the factors and impacts involved.

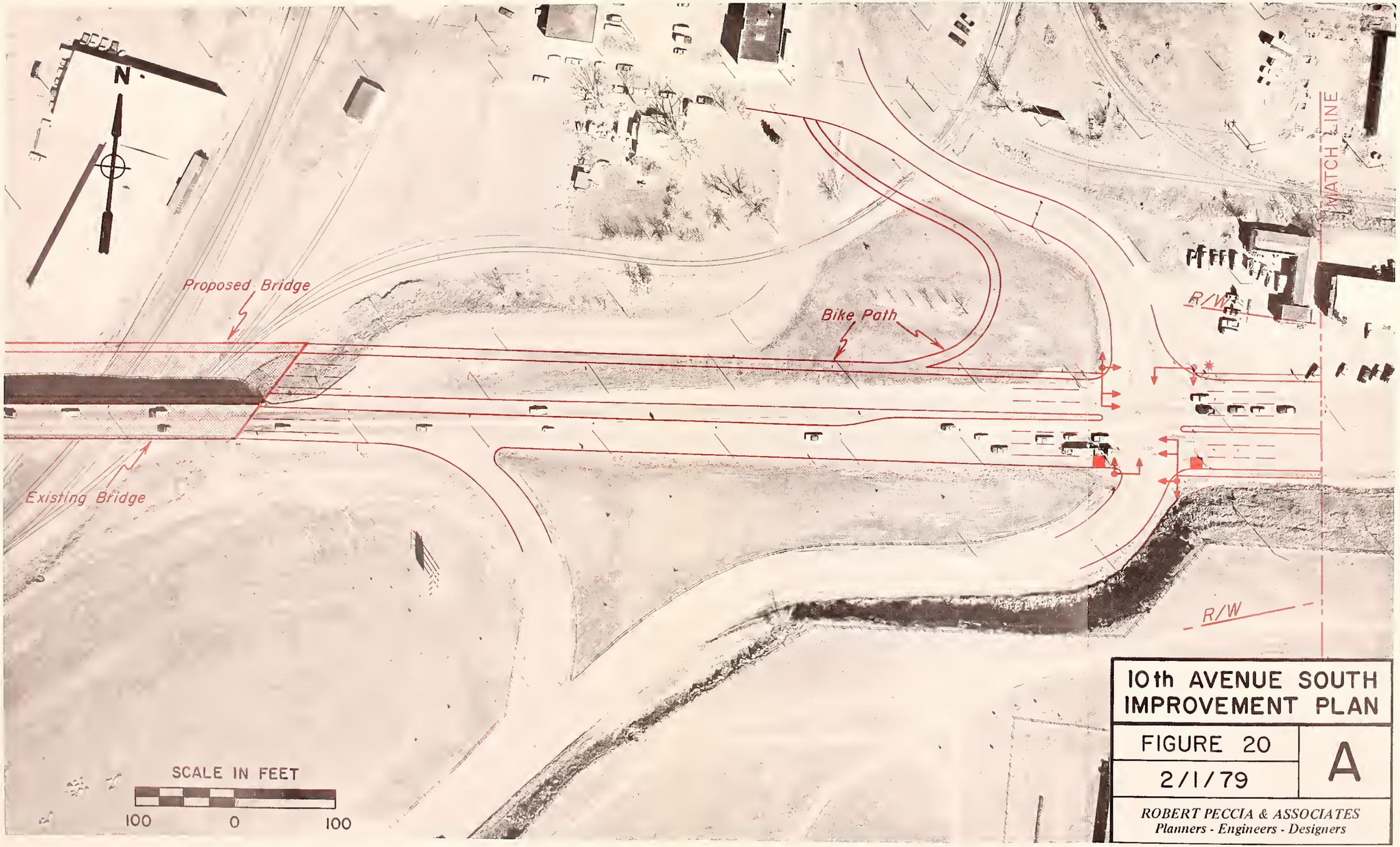
The complete text of the public comments received on this project are reproduced in the Tenth Avenue South Improvement Plan - Technical Supplement.

- FIGURE 20 -

PHOTOGRAPHIC PLAN VIEW of RECOMMENDED IMPROVEMENT PLAN

LEGEND





10th AVENUE SOUTH IMPROVEMENT PLAN

FIGURE 20	A
2/1/79	

ROBERT PECCIA & ASSOCIATES
Planners - Engineers - Designers

N

4th St.

5th St.

6th St.

MATCH LINE

MATCH LINE

One Way

Recommended New Signalized Intersection

Husky

R/W

Skylark Motel

Daytan Tire Dealer

One Way

Chevron

One Way

35 M.P.H.

R/W

Bison Ford

One Way

SCALE IN FEET

100 0 100

10th AVENUE SOUTH IMPROVEMENT PLAN

FIGURE 20

2/1/79

B

ROBERT PECCIA & ASSOCIATES
Planners - Engineers - Designers

N

MATCH LINE

7th St.

8th St.

9th St.

MATCH LINE

Western Volkswagen

R/W

Novco

Brass Rail Bar

Exxon

R/W

Gordon's Restaurant

Conoco

Village Motor Inn

Brunswick Skyway Bowl

SCALE IN FEET

100 0 100

10th AVENUE SOUTH IMPROVEMENT PLAN

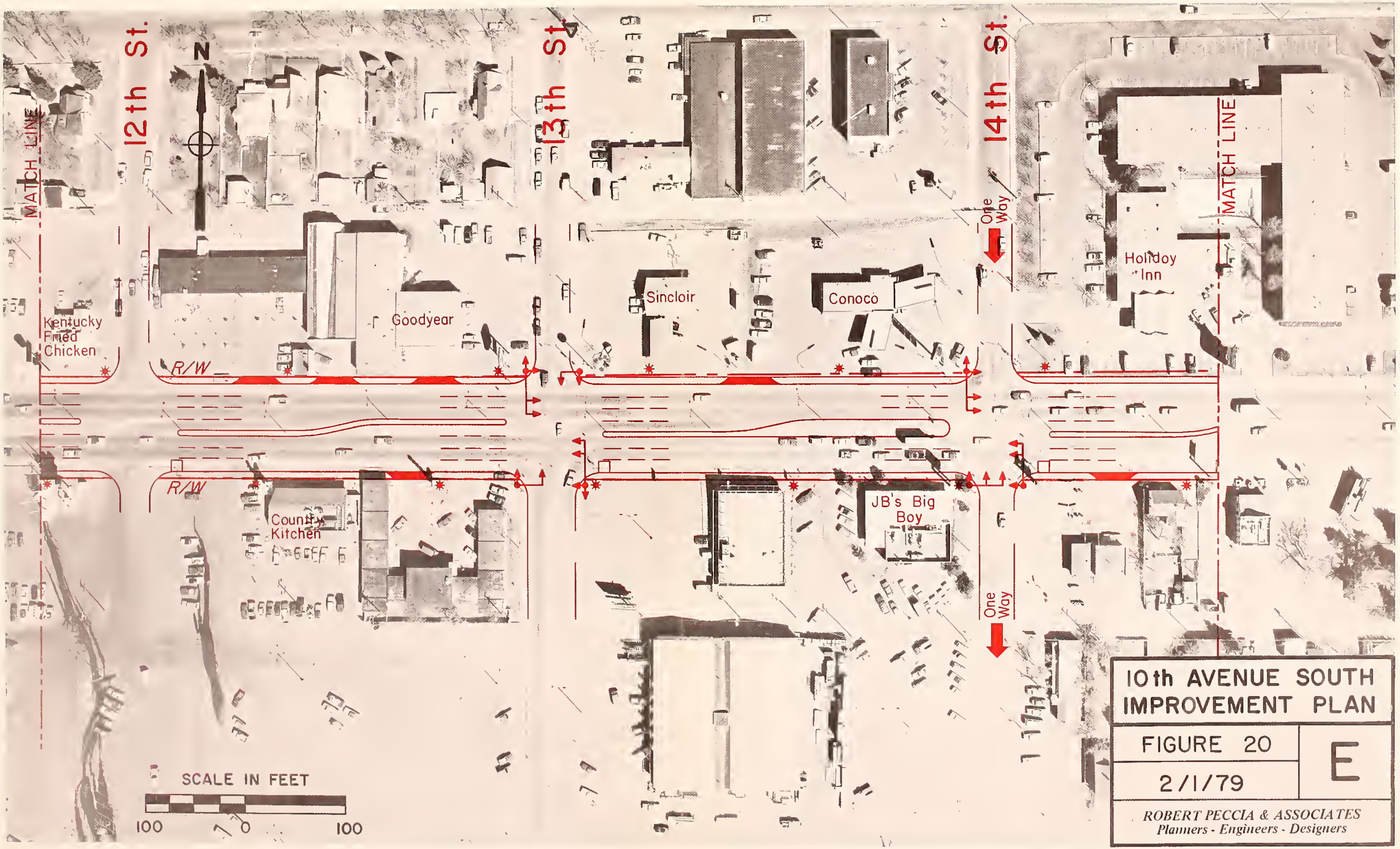
FIGURE 20

C

2/1/79

ROBERT PECCIA & ASSOCIATES
Planners - Engineers - Designers

N
10th St.
11th St.
MATCH LINE
MATCH LINE
Husky
Frontier Dodge
R/W
R/W
Montgomery Ward & Co.
Coost to Coost
SCALE IN FEET
100
0
100
10th AVENUE SOUTH IMPROVEMENT PLAN
FIGURE 20
D
2/1/79
ROBERT PECCIA & ASSOCIATES
Planners - Engineers - Designers



10th AVENUE SOUTH IMPROVEMENT PLAN

FIGURE 20

E

2/1/79

ROBERT PECCIA & ASSOCIATES
Planners - Engineers - Designers

N

MATCH LINE

Holiday Inn

15th St.

16th St.

17th St.

One Way

Amoco

NAPA

Burger King

Husky

MATCH LINE

R/W

R/W

Big Dipper

35 M.P.H.

Pizza Hut

Gabe's Auto Sales

S.A. Gas

One Way

SCALE IN FEET

100 0 100

10th AVENUE SOUTH IMPROVEMENT PLAN

FIGURE 20

F

2/1/79

ROBERT PECCIA & ASSOCIATES
Planners - Engineers - Designers

N

MATCH LINE

McDonalds

R/W

NCR

18th St.

R/W

Shakey's Pizza Parlor

19th St.

35 M.P.H.

20th St.

MATCH LINE

Sambo's

SCALE IN FEET

100 0 100

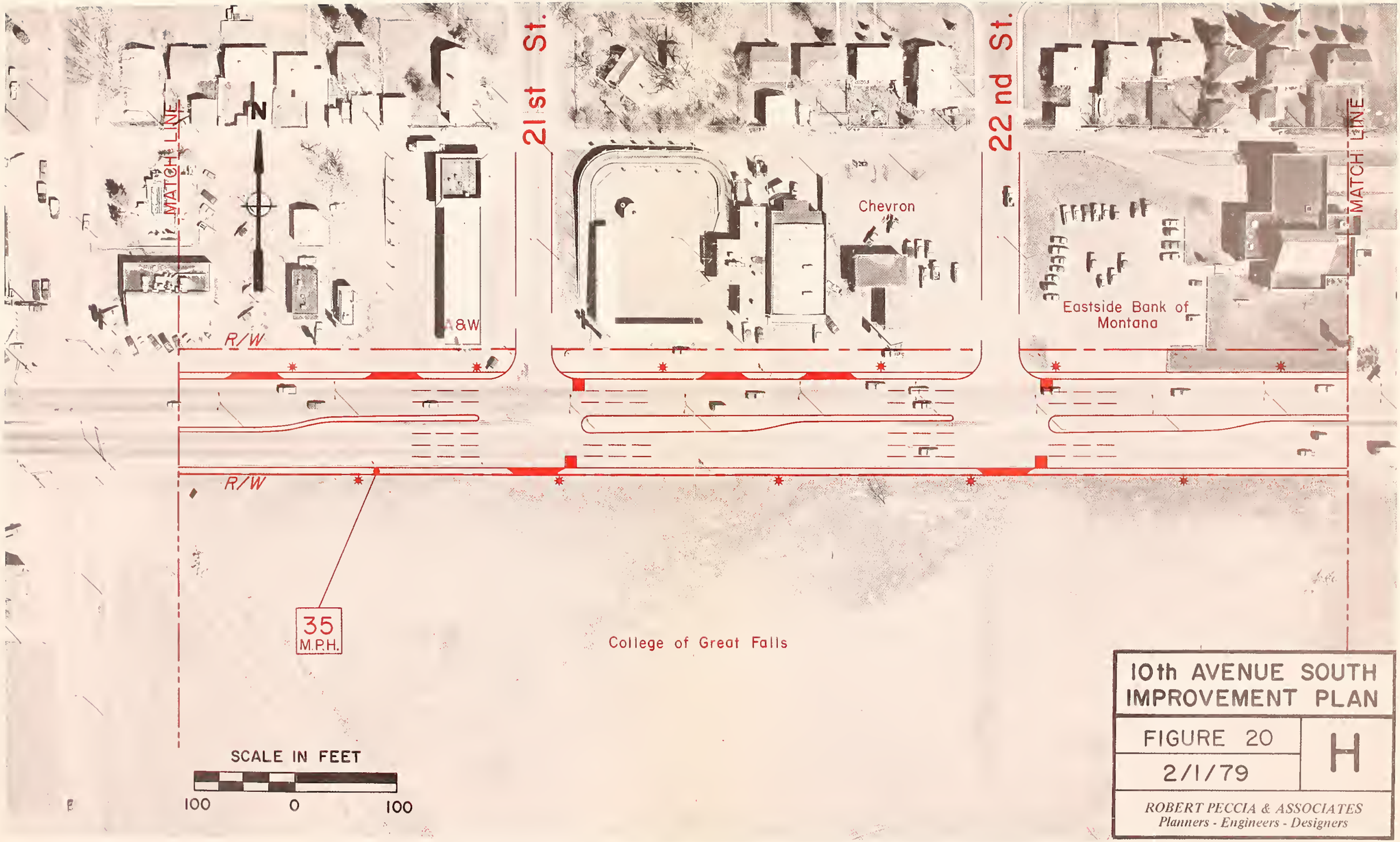
10th AVENUE SOUTH IMPROVEMENT PLAN

FIGURE 20

2/1/79

G

ROBERT PECCIA & ASSOCIATES
Planners - Engineers - Designers



10th AVENUE SOUTH IMPROVEMENT PLAN

FIGURE 20 — H

2/1/79

ROBERT PECCIA & ASSOCIATES
Planners - Engineers - Designers

N

MATCH LINE

23rd St.

R/W

Great Falls Federal Savings & Loan

35 M.P.H.

One Way

25th St.

Anthony's

MATCH LINE

R/W

Standard

Exxon

Town & Country

One Way

24th St.

SCALE IN FEET

100 0 100

10th AVENUE SOUTH IMPROVEMENT PLAN

FIGURE 20

2/1/79

I

ROBERT PECCIA & ASSOCIATES
Planners - Engineers - Designers

N

MATCH LINE

26th St.

27th St.

MATCH LINE

One Way

Buttrey Food Store

Montana Liquor Store

Husky

Lion Park

R/W

R/W

Ranch-O Motel

35 M.P.H.

Hi Ho Tavern

Northern Leasing Co.

One Way

SCALE IN FEET

100 0 100

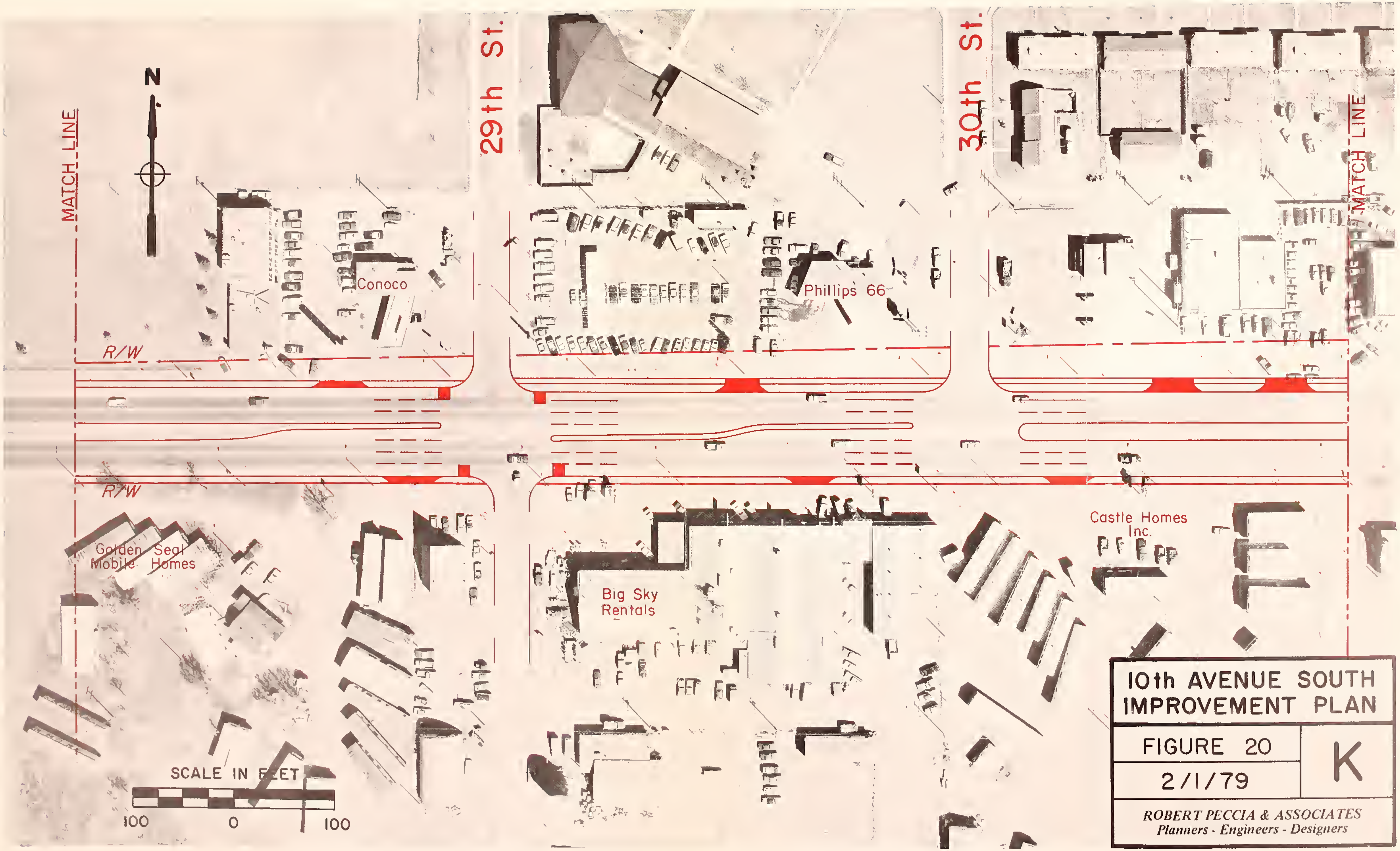
10th AVENUE SOUTH IMPROVEMENT PLAN

FIGURE 20

J

2/1/79

ROBERT PECCIA & ASSOCIATES
Planners - Engineers - Designers



10th AVENUE SOUTH IMPROVEMENT PLAN

FIGURE 20

K

2/1/79

ROBERT PECCIA & ASSOCIATES
Planners - Engineers - Designers

N

MATCH LINE

32nd St.

MATCH LINE

93 Leasing

Exxon

35 M.P.H.

R/W

Midi-Mart

R/W

35 M.P.H.

Safeway

Johnson Carpet Co.

33rd St.

SCALE IN FEET

100 0 100

10th AVENUE SOUTH IMPROVEMENT PLAN

FIGURE 20

2/1/79

L

ROBERT PECCIA & ASSOCIATES
Planners - Engineers - Designers

N

MATCH LINE

34th St.

U.S. Post Office

Midwoy Toyota, Inc.

IGA

36th St.

Mobil

MATCH LINE

R/W

R/W

Louttit Mobile Home & Travel Trailer Sales

Blue Cross of Montana

34th St.

SCALE IN FEET

100 0 100

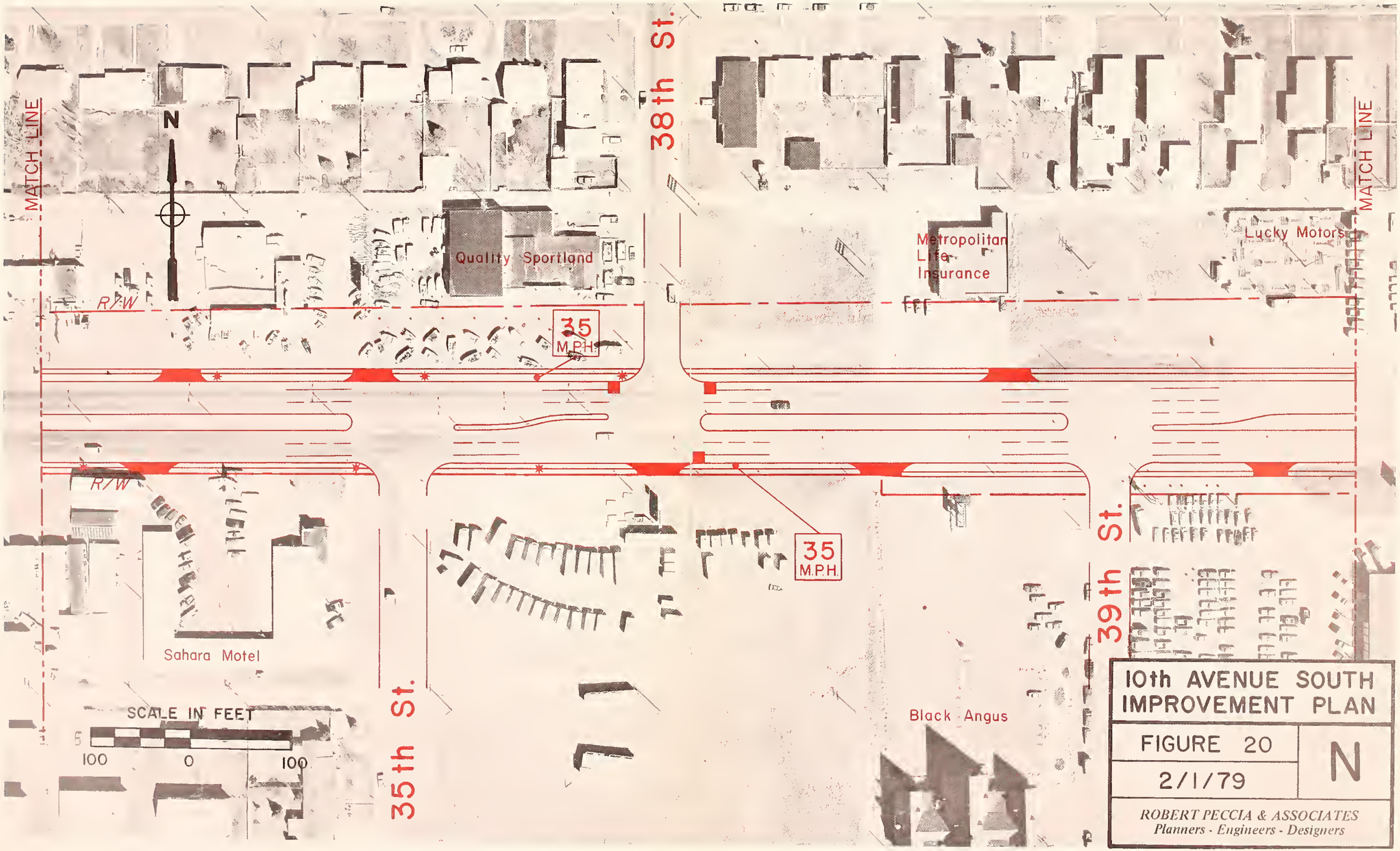
10th AVENUE SOUTH IMPROVEMENT PLAN

FIGURE 20

2/1/79

M

ROBERT PECCIA & ASSOCIATES
Planners - Engineers - Designers



10th AVENUE SOUTH IMPROVEMENT PLAN

FIGURE 20

2/1/79

N

ROBERT PECCIA & ASSOCIATES
Planners - Engineers - Designers

N

MATCH LINE

40th St.

Shasta Motel

Modern Equipment Company

MATCH LINE

Royal Motors

R/W

R/W

City Motor Company

Rice Motors

McCollum Modern RV's

SCALE IN FEET

100 50 100

10th AVENUE SOUTH IMPROVEMENT PLAN

FIGURE 20

2/1/79

O

ROBERT PECCIA & ASSOCIATES
Planners - Engineers - Designers

N

MATCH LINE

V.F.W.

Doris Dr.

R/W

35 M.P.H.

Montana Power

Bike Path

Tourist Information Center

MATCH LINE

Drainage Ditch

Drainage Ditch

R/W

45 M.P.H.

Hawk Electric & Plumbing Supply

SCALE IN FEET

100 0 100

10th AVENUE SOUTH IMPROVEMENT PLAN

FIGURE 20

2/1/79

P

ROBERT PECCIA & ASSOCIATES
Planners - Engineers - Designers

47th St.

49th St.

MATCH LINE

MATCH LINE

N

Honda Motorcycles
Sales & Service

R/W

Bike Path

Drainage Ditch

36" R.C.P.

Drainage Ditch

R/W

American
Furniture

RV Sales

SCALE IN FEET

100 0 100

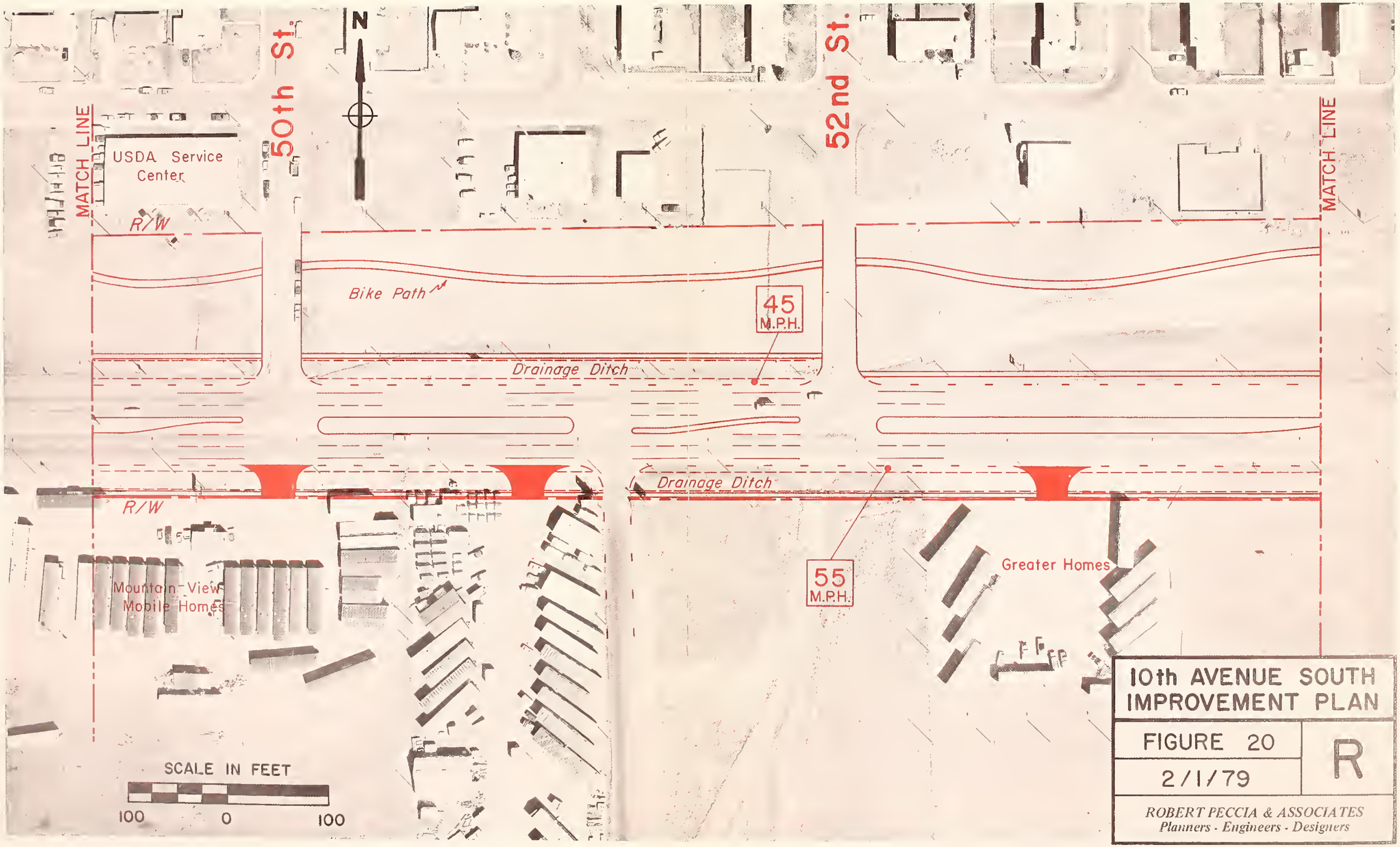
10th AVENUE SOUTH IMPROVEMENT PLAN

FIGURE 20

Q

2/1/79

ROBERT PECCIA & ASSOCIATES
Planners - Engineers - Designers



10th AVENUE SOUTH IMPROVEMENT PLAN

FIGURE 20

R

2/1/79

ROBERT PECCIA & ASSOCIATES
Planners - Engineers - Designers

54th St.

57th St.

MATCH LINE

R/W

Bike Path

R/W

Drainage Ditch

N

SCALE IN FEET

100 0 100

10th AVENUE SOUTH IMPROVEMENT PLAN

FIGURE 20	S
2/1/79	

ROBERT PECCIA & ASSOCIATES
Planners - Engineers - Designers